

# Aviation Week & Space Technology

April 15, 1963

PILOT REPORT:

**STOL Controls  
Increase Wren  
Performance**

Marine/Sikorsky CH-53A  
Heavy Assault Helicopter

75 Cents

A McGraw-Hill Publication



**Sperry Airborne Anti-Collision System Displayed**



**ANCHOR FOR 7.5 MILLION POUNDS OF THRUST** Now under construction for the National Aeronautics and Space Administration at Marshall Space Flight Center, the Saturn Static Test Stand, largest in the free world. Designed by AETRON under the direction of the Corps of Engineers, U. S. Army Engineer District, Mobile, Alabama.

**AETRON**

Costa Mesa, California • A Division of Aerojet-General Corporation



**707, 720 and 727**

**hi-Lok**

**REDUCES THE INSTALLED  
COST OF FASTENERS**



ABOVE: Fiberglass stringers in the exterior area of the Fin Panel are joined to aluminum stringers. Evenly controlled clamping of Hi-Lok prevents warping or crushing.

LEFT: Wing rib structure assembled with Hi-Loks. High pre-load fastener is required in critical fatigue stress areas.

ABOVE: Maximum tool clearances and return flanges in wing primary structure are easily overcome by Hi-Lok 90° and other installation tooling.

• Hi-Lok Fasteners do many things in Boeing's expanding family of jet airplanes. Basically, though, the Hi-Lok was selected by Boeing structural engineers to obtain a lower installed cost and for its high pre-load capability when compared to collar winged fasteners.

The installed cost of the fastener includes hole preparation and the time to install and inspect as well as the fastener itself. All contribute to the price tag of assembled structure.

Versatility of Hi-Lok installation tooling permits the use of Hi-Loks in many areas not feasible to other fasteners. This versatility results from a successful marriage of Hi-Lok adapter tools to standard light weight air motors. No bulky, single-purpose power equipment is needed.

In open structural areas, Hi-Loks can be installed up to 45 per minute using Hi-Lok collar-free tooling. This automatic equipment can install 200 Hi-Lok collars or Hi-Lok pins without reloading.

In fastening dissimilar materials such as combinations of wood, fiberglass and metals, the Hi-Lok is ideal because of its fundamental concept to control pre-load, eliminating the risk of crushing or crushing of softer materials. For these reasons plus ease of installation, the Hi-Lok Fastener has become officially approved for naval aviation construction.

**TYPICAL hi-Lok ADAPTER TOOLING**

(not color by hand, hand)  
Pilot to Standard for Hi-Lok



PLUS  
STANDARD  
BOLT  
WASHERS

**hi-shear**

**CORPORATION**

3035 WEST BATH STREET • TORRANCE • CALIFORNIA

ARCHITECTURE • ENGINEERING • INSTRUMENTATION • FABRICATION • CONSTRUCTION MANAGEMENT



## Look into

Reeves

## UNIQUE SYSTEMS CAPABILITIES



Systems project managers can save time and money, and achieve operational excellence faster by working with Personel's experienced design and installation teams.

Retired/ comprehensive experience in the fields listed has resulted in many former achievements. This experience, combined with extensive, smoothly operating production and test facilities, permits us to make no major assignments.

A review of what Reeves has done, is doing, and can do, will demonstrate the unique character of our capabilities... for systems, subsystems, assembly and component development, engineering, production, supply and field service. Data file T04 on request.

#### FOR EXAMPLE: FUZING SYSTEMS

Reeves has many years of experience in the design, development, and quality production of highly sophisticated flying devices.

Impact, pulse doppler radar, F.M. radio, and electrostatic fuses have been developed and produced for a number of advanced weapons systems, including Navy Graceloff.

Supplementing these, Reines has also developed a line of check-out equipment employing FM/FM telemetry and electronic core modules for in-flight check-out of complete firing systems.

<sup>a</sup> Qualified respondents who are seeking more drug information (as for their safety as they use natural fields are asked to get a result such as



**SUBJECTS AND EXPERIMENT** Subsequent work by Schacter et al. (1986) and Kahn and Kahn (1987) extended the

*Systems engineering...management...production...field services*

## AEROSPACE CALENDAR

Apr. 23-27 Annual Meeting, National Aeronautics Section, AAS, Washington, D. C.

Apr. 23-24 Annual Meeting, Space Flight Symposium, AAS/NASA, Houston, Texas, Dallas, Tex.

Apr. 23-24-25 Third Annual San Diego Space Symposium, American Astronautical Society, Del Mar, California

Apr. 23-25-30 Weather Radio Conference, American Meteorological Society, San Francisco, California

Apr. 23-25-Hypersonic Research Conference, AIAA/AFOSR, Naval Ordnance Laboratory, White Oak, Md. (Secret)

Apr. 23-25-26-27-28-29-30 Symposium on Ionospheric Research, Oklahoma State University, Stillwater, Okla.

Apr. 23-28 Annual Conventions, Society of Automotive Engineers, Inc., New York, United States, N. Y.

Apr. 23-28-30-1 May Spring Meeting, Western States Section, The Combustion Institute, University of California, Davis, California

Apr. 23-28-29-30 Symposium on Astronautical Sciences, General Dynamics/AFOSR/USAF, Dayton, Ohio

Apr. 29 May 2-1964 Annual Scientific Meeting, Aerospace Medical Assn., Salt Lake City, Utah

Apr. 29 May 2-23rd Annual National Conference, Society of Aeronautical Engineers, Sheraton-Biltmore Hotel, St. Louis, Mo.

Apr. 29 May 2-3 Spring Meeting, United States (Continued on page 7)



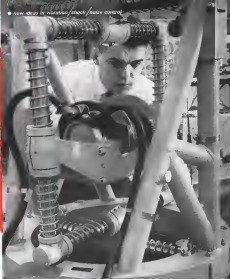


Photo courtesy: Ruben Drenth, Drexel Aircraft Corp.

## total survival system

Take a look at this protective suspension for Norden's shipboard inertial platform. Never before has a mounting system controlled such large shock forces in so little space. ■ Lord engineering is responsible for the design. And for its unprecedented performance which allows equipment survival and accurate operation after massive shocks. ■ System accomplishes dramatic reduction of 500 to 1000 G shock inputs, with only 6 to 7 G transmitted to the inertial navigator. ■ Returnability within 1/2 of angle effective isolation of 5 to 33 cps vibrations. ■ You may not need as complex a protective system. But whatever your requirement, you can expect more from Lord—for Lord capability is a matter of record. Contact: Lord Manufacturing Company, Inc., Pa. Field Engineering Offices in principal cities. In Canada: Railway & Power Engineering Corp., Ltd.

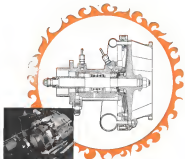


## AEROSPACE CALENDAR

(Continued from page 5)

- Senior National Committee of International Scientific Radio Union (UISR), National Academy of Sciences, National Research Council, Washington, D.C.
- Apr. 29-May 1—Annual Conference, Society of Photographic Scientists and Engineers, Ambassador Hotel, New York City, N.Y.
- Apr. 30—Army Research Office
- May 3—Fifth Louis D. Casler Lecture in Time, N. Square, N., on Turbopropulsion, Krieger Associates, Massachusetts Institute of Technology
- May 3-5—19th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D.C.
- May 4-7—Third National Conference on the Peaceful Uses of Space, Chicago 11 Square, NADA, Committee for Extension and Control Development of Chicago
- May 7—Midwest Space Laboratory Conference, AIAA/AAS/ASME, Madison Area, Scott Hilton Hotel, Los Angeles, Calif.
- May 23—Fourth National Symposium on Human Factors in Electronics, IEEE, Marriott Twin Bridges Motel, Washington, D.C.
- May 24—International Travel Fair and Flying Display, Regent Hotel, London, Kent, England
- May 25-26—19th Annual Conference, American Association of Airport Executives, Gulf Coast Mills, Beach Club and Court, Ridge Beach, Fort Lauderdale, Fla.
- May 26—Electronic Gasparovich Conference, Institute of Electrical and Electronics Engineers, International Inc., Washington, D.C.
- May 29—NADA Annual Symposium, Institution Society of America, Bell, Via Blvd., San Francisco, Calif.
- May 29—Electronic Gasparovich Conference, Institute of Electrical and Electronics Engineers, International Inc., Washington, D.C.
- May 29-30th Meeting, National Aerospace Standards Committee of the Aerospace Industries Assn., Sheraton, New York, N.Y.
- May 31-3rd Spring Meeting, Society for Experimental Stress Analysis, Hotel Britannia, Seattle, Wash.
- May 9-10—Quarterly Regional Meeting, Assn. of Local Timpani, Atlanta, Ga., North, Tex.
- May 13-14—National Aerospace Electronics Conference, IEEE/AIAA, Dayton, Ohio
- May 15-16—Fourth Annual Symposium on High Speed Testing, Shock Sources, Boston, Mass. Sponsor: Flu-Tech Equipment Corp.
- May 19-21—Conversion General Flight, Farnborough, Bedford, Conn.
- May 20-22nd Annual Symposium Conference on Marketing in the Defense Industry, American Marketing Assn., Boston College, Boston, Mass.
- May 20-21-17th Annual Convention and Exhibit, American Society for Quality Control, Western Plaza, Chicago, Ill.
- May 20-22—National Symposium on Successive Theory and Technology, Institute of Electrical and Electronics Engineers, New York Hotel, New York, N.Y.

(Continued on page 9)



## THIS HIGH SPEED ASSEMBLY UNAFFECTED BY EXTREMES OF ACCELERATION AND TEMPERATURE

Engineers find rewarding opportunity for accomplishment at Sundstrand Avionics Division. For example in the design of high speed, high temperature, high energy turbine machinery for certain models of their dynamic space power systems, Sundstrand engineers solved the problems associated with acceleration and extreme temperature gradients. The result is the high-speed single-shaft turbine pictured above. Here, the turbine shaft, an integral part of the turbine disc, is supported on two angular contact, pre-loaded ball bearings. Loss of preload on the bearings is prevented by the sleeve which material was selected to provide expansion equal to that of the turbine shaft during the heating transient after startup. Spacing between the pre-load sleeves permits one bearing to pick up an acceleration thrust load from vehicle maneuvers without relieving the other bearing. This also makes possible accurate positioning of the turbine wheel and maintenance of close tolerances between turbine wheel and pre-load sleeves.

Lubrication and cooling is provided by jets of oil impinging on each bearing. A front-type seal prevents loss of oil at the turbine wheel hub and prevents mixing of the primer-mover gases with the lubricant supply. Normal operating speed for this application is 60,000 RPM.

Sundstrand is continually looking for talented engineers. If you are interested in working with advanced technical groups on chemical and solar space power systems, write our Director of Personnel. For more detailed product information simply direct an inquiry on your company letterhead to: Manager, Applications Engineering.



## SUNDSTRAND

### AVIATION • DENVER

A DIVISION OF SUNDSTRAND CORPORATION • AN EQUAL OPPORTUNITY EMPLOYER

2480 WEST 70TH AVE., DENVER 21, COLO.

FACILITIES IN DENVER, COLORADO AND ROCKFORD, ILLINOIS







## STOKES NAMED PRIME CONTRACTOR FOR NEW DOUGLAS SPACE FACILITIES



Below is a view of Douglas Aircraft Environmental Test Center. Stokes alone has more of similar facilities to be built than any other contractor. To the left are two Stokes 5 ft. 6 in. Gun is shown with the other simulator now being designed for it.

The Stokes Space System Department has been named prime contractor for the design and installation of three new space environment simulation chambers, key elements in Douglas Aircraft Corporation's privately financed Space Systems Center at Huntington Beach, California. The largest and most technically advanced space-test facility on the West Coast, the Center will be an integral part of Douglas' Missile and Space System Division.

The largest chamber, 30 ft. in diameter, will be capable of testing fully assembled vehicles scheduled for manned flight. It will be used in the Saturn program, and in the development of lunar and planetary probe vehicles. The Stokes systems will represent the most advanced state-of-the-art in completion, and are designed for updating to even higher simulation parameters in the future. Stokes units similar to these are now achieving vacuum in the 10% Torr range. High-speed cryogenics at all three chambers at 30° K will assure the attainment

of true orbital vacuum, even under high gas loads. Stokes has equipped CryoVac, for the design, fabrication and installation of cryogenic systems, and owned Pittsburgh-Des Moines Steel Company to furnish and erect the large steel apertures.

A deciding factor in the selection of the prime contractor was Stokes' experience in designing and building large, fast-of-a-kind space test facilities, such as those installed at G. E. & Space Technology Center. Another was Stokes' related background in space vacuum and cryogenics, as represented by General Electric's and Goddard's 888 and DTC systems. To this experience, Stokes adds its long and successful history in the development of large-scale industrial equipment utilizing ultra-high vacuum, thorough engineering design and construction, fabrication facilities, and field service service as integrated, start-to-finish capability unique in the entire area of space environment simulation. Space Systems Department, P. A. Stokes Corporation, 1580 Taylor Road, Philadelphia 20, Pa.

P. A. STOKES CORPORATION: PHILADELPHIA / LONDON / TORONTO

**STOKES**

For the world of the Douglas concludes in Series built 25 at the 100% Best.



## Beech-built "missing link" ends make-believe training

*KD2B-1, now being produced under U. S. Navy contract, is another example of Beech's systems management capability*

The Beech KD2B-1—shown above—is America's first missile target system to match the performance of the fastest enemy jet. It made the need for target testing, taking, or simulation of any sort. By matching actual supersonic aircraft speeds, altitudes and target characteristics, it makes possible low-cost realistic training. It can evaluate proficiency of every advanced weapons system, including radar-directed and homing missiles.

But weapons evaluation is only one of the many jobs the Beech KD2B-1 is capable of doing. It has capabilities for use as an inexpensive operational

missile. Its payload capacity and low-maintenance design fit it admirably for a wide range of tactical missions.

The KD2B-1 is easily adaptable to air-launching, surface-launching, or ship-launching with existing equipment. It is capable of Mach 2 speeds at 70,000 feet and Mach 3 speeds at 100,000 feet.

Designing, developing and building missile systems is one of the many elements that make up the comprehensive Beech capability. It's one reason Beech is prepared to undertake complete systems management responsibilities for a wide range of space-age projects.

**Beech Aerospace Division**

BEECH AIRCRAFT CORPORATION • WICHITA 1, KANSAS



**DELIVERING BUSINESS OWNERS' VALUE** Only Beechcraft's effort with a complete line of planes with an multi-task, range, service and speed to help business multiply the money-making decisions that each top man can make. That's how thousands of Beechcrafts have paid for themselves.

For full information about how you may take advantage of Beech's proven design talent, write, send or phone request. Address: Beech Aircraft Corp., Wichita 1, Kansas.

**Remember: Write today for:** ☐ "Beech and Some of Beech's Plans" ☐ Beech Training and Research Plan ☐ Beech Aircraft, Inc. on business. Address: Beech Aircraft Corp., Wichita 1, Kansas, U.S.A.





**Garrett-AiResearch**

## OVERHAUL and REPAIR

### QUALITY

- All parts to support our many product lines are made by Garrett-AiResearch under the same high quality control conditions as in the original manufacture.
- Highly skilled personnel are specially selected and trained in Garrett-AiResearch products.
- Finest factory and test facilities available at each of our manufacturing centers—FAA approved.
- 90 day warranty after first use, or 180-day warranty after delivery.
- Analytical engineering programs permit us to make improvements to extend time between overhaul and reduce operating costs.
- Experience—a quarter century in refined product lines.

### COST

- Lower cost because of established factory controls, high volume, and extensive technical knowledge of our own products.
- Established price lists that enable you to estimate future costs accurately.

### SERVICE

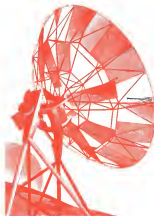
- On-day turn-around on all equipment.
- Unit exchange programs for gas turbines and other Garrett-AiResearch equipment on custom corporate aircraft.
- 800 field service engineers on constant call throughout the world.
- Backed up by total support programs (spare inventory, technical publications, training programs, etc.).

Please direct your inquiries to Support Services at any of the divisions listed below.

**AIRESEARCH MANUFACTURING DIVISION** • Los Angeles, California

**AIRESEARCH MANUFACTURING DIVISION OF ARIZONA** • Phoenix 36, Arizona

**GARRETT MANUFACTURING LIMITED** • Toronto, Ontario, Canada



RCA-A2696



RCA-A15048



RCA-A15038

## RCA SUPER-POWER COAXITRONS

Integral Circuitry Offers Pulse-to-Pulse Frequency Agility as a Result of Inherent Broad Bandwidth

The Coaxitron is an electronic concept that integrates the radio-frequency input and output circuitry, high-voltage blocking circuit, and the gridded tube structure. The integral circuitry, requiring no external tuning, offers high efficiency, broad bandwidth, high power gain, and high reliability.

The RCA family of Coaxitrons now includes three developmental types—A-10509, A-10508, and A-2696. These tubes are suited to a variety of systems applications including long-range radars, broad-band multifunction communications, and particle accelerators. These tubes

operate wherever operation in a counter-propagation environment is necessary since the broad bandwidth permits pulse to pulse frequency variation without tuning.

The RCA-A10506 was developed by RCA under contract to the Rome Air Development Center. The RCA-A2696 was developed by RCA under contract to the Bureau of Ships, U.S. Navy.

For further information, consult your RCA Industrial Tube Representative, or write Marketing Manager, Industrial Tube Products, RCA Electronic Tube Division, Lancaster, Pa.

Typical Operating Conditions of RCA Coaxitrons

	Power Output (dBm)	Peak Power (dBm)	Peak Voltage (kV)	Peak Current (mA)	Peak Frequency (MHz)
RCA-A10509	100	150	15	30	100
RCA-A10508	100	150	15	30	100
RCA-A2696	100	150	15	30	100

Information: RCA ELECTRONIC TUBE DIVISION

General Sales Office: 1000 N. 10th St., Suite 100, Lancaster, Pa. 17602 • Tel: 717/393-1000 • Telex: 176020 • Cable: RCA • RCA Industrial Tube Division: 1000 N. 10th St., Suite 100, Lancaster, Pa. 17602 • Tel: 717/393-1000 • Telex: 176020 • Cable: RCA • RCA Electronic Tube Division: 1000 N. 10th St., Suite 100, Lancaster, Pa. 17602 • Tel: 717/393-1000 • Telex: 176020 • Cable: RCA



The Most Trusted Name in Electronics





**on target with modern turbine power:** In production since 1955 and to continue for many years under current military planning, Allison's T56 turboprop powers the C-130 transport for the USAF, Marines, Coast Guard and Navy, the USN P3A sub killer, and the E2A AEW. Soon, with air-cooled turbine blades, the T56 will be even mightier and still more sparing in use of fuel. The T56 is one more example of on target performance in aerospace programs involving nuclear, solar and chemical energy conversion.

**Allison**   
THE ENERGY DIVISION OF  
GENERAL MOTORS, WARREN, MI 48090



**"TRANSPORT HEAVY... POSITION PRECISELY"**

How to move a space launch vehicle from assembly and checkout to the launch complex ready for firing. In solving mobility problems such as this, Clark Equipment Company applies more than 50 years' experience in power transmission, material handling and transportation equipment development and manufacture. Only Clark has this unity of demonstrated capability. Invite Clark Equipment Company to participate in an operations analysis, product or system development approach to your mobility problem. Write or call Neugier, Clark Development Division, Clark Equipment Company, Battle Creek, Michigan.

**CLARK**  
EQUIPMENT





A small squirt from a vent valve in a dark corner of space . . .

. . . evidence of Pesco cryogenic components at work. Advanced models of vent valves, boost pumps, chilldown pumps, and submersible AC and DC cryogenic electric motors are on the test stands at Pesco's own cryogenic laboratory right now. If you would like to receive periodic reports on Pesco's progress in cryogenic components development, send your name and address to . . .

**PESCO PRODUCTS DIVISION**  
Borg-Warner Corporation

24700 North Miles Road • Bedford, CH4

**EXPORT SALES:** Borg-Warner International Corp., 86 South Wabash Ave., Chicago 3, Illinois



BORG-WARNER



## Need a replacement for obsolescent communications?

From tin eels to laser systems, the path of communications has transcended language, wars and centuries. On the ground, at sea, in the air . . . and now in space . . . the system of today has always become the tin can of tomorrow. □ For more than a decade, research and development by Electronic Communications, Inc., has helped set the pace in advanced and reliable communication. Among ECI's significant achievements are — the first UHF airborne multiplex system, the first self-focusing multiple-element antenna array, the first airborne 50-watt UHF command set, the first demonstration of unequal array spacing techniques, the first airborne 1-kilowatt servofocused UHF transmitter and the first development of a one-milliwatt superheterodyne radiometer. □ If your communications system is losing the battle of time, take advantage of ECI research and development . . . it may dramatically improve your present methods. To find out what's new in communications . . .

.....**Ask**  
ELECTRONIC COMMUNICATIONS, INC.  
St. Petersburg, Florida











BULLS-EYE THROUGH A 150-FOOT SLOT AT 70,000 FEET BEYOND MACH 2



OR A 42-FOOT SLOT AT 40,000 FEET



As greater certainty in verbal representation of aircraft becomes necessary, the Litton LC-4 Air Data Computer is the off-the-shelf answer. Airframe resolution of 1 foot at sea level and 7 feet maximum at 70,000 feet is another one of many outstanding characteristics of the soundly-engineered, maintenance-oriented LC-4. Built to ARINC 660 requirements and meeting or surpassing specifications listed therein, the LC-4 is a high-precision, fully-modular, tight data computation system. No other system has comparable capability or ease approach its ease of maintenance at all levels. Outputs include the five most widely used ones—altitude, mach number, true airspeed, indicated airspeed, and

static air temperature—plus many optional outputs and alarms can be programmed. All subsystems modules are of straight plug-in design, standardizing the need for any alignment, calibration, or adjustment during replacement or removal of modules. Compliance with ARINC 660 can be achieved by using only the altitude and mach modules. The LC-4 is just one of many air data products for subsonic and supersonic applications available from Litton. Others include pressure static computers, flight test instruments, precision altimeters, plus laboratory and flight line test equipment. Complete literature will be forwarded on request. Write: Air Data Systems, 5508 Canoga Ave., Woodland Hills, Calif. Phone 346-4542.



**LITTON SYSTEMS, INC.**  
AIRFRAME & CONTROL SYSTEMS DIVISION  
THE WORLD'S LARGEST PRODUCER OF INFLIGHT  
INSTRUMENT SYSTEMS FOR MILITARY AIRCRAFT

## EDITORIAL

### The Brittle Brilliance

It is sad for anybody who watched President John F. Kennedy inaugurate that frosty January day in 1961, with the words of his address glittering with the same brilliance as the bright winter sun reflecting from the snowbanks on Capitol Hill, to measure the low estate to which this Administration has fallen as it pined and came and headed down the basement stairs toward the 1964 accounting with the electorate.

So much of that early brilliance has proved too brittle under the stress and strain of international and domestic pressures, so much of that intelligence lacked sufficient control to prevent its growth into over-the-top action, so much of that apparent candor and refreshing frankness degenerated so quickly into the dry half-truth, the calculated falsehood and the crude stage management of news, as many of the early achievements have proved so much less substantial under the cross of time and truth, and so many of them have been exposed for simple political legions to the loss of the courageous rational leadership that was promised.

When the epitaph of the Kennedy Administration is written, certainly "Cuban" should be etched in the largest letters. From the Bay of Pigs invasion through the latest phase of ordering anti-Castro guerrillas the Administration has thus flummoxed the American people in a shameful manner. That, more than anything else to date, has backfired with such vigor that the Administration's original popularity has hit the skids. It is difficult for the American people to stomach the spectacle of this government and its allies doing Castro's police work for him while at the same time permitting him to export subversion and Communist agents by the thousands all over Latin America.

#### Skybolt Jolt

The job of the Skybolt cancellation is still resounding among our allies and has further reduced the credibility factor of this Administration. Other nations most wonder at the Administration logic that scrapped Skybolt before its test program had reached full stride while at the same time it placed its major nuclear force into the Minuteman missile which, after two years of intense testing and frantic development fees, still cannot meet its range and payload requirements.

If the Administration's action over Bomarc were intended to measure how severe a strain U.S.-Canadian relations could endure without breaking, they accomplished their purpose.

Despite all of the test failing penitence on an ordinary day in the Defense Dept., this budget continues to climb sharply. The Senate investigation of the TFX contract award has revealed just how spacious most of this Pentagon cost-efficiency doubletalk really is. The TFX investigation has also raised the question as to how a Secretary of Defense who is so obtuse in his relations with the legislative branch of the government can really be as reliable as he claims on other more complicated issues. It is evident that no matter how brilliant their computer exercises or back-of-envelope pencil calculations may seem to them, the top civilian leaders of the Pentagon have failed to win the respect, loyalty and confidence from the working levels that any commander needs from his troops to operate successfully. This is a situation that the country cannot safely endure for very long.

#### Space Budget Problems

After a belated, emergency start in the space business, the Administration is being effectively challenged both on the management of this vast expenditure of public funds and also on the value of the goals it has set. It is doing an increasingly hampering job of backing these criticisms and explaining to the taxpayers what the space race is really all about. Its original thin veneer of bull-hug has become transparent and there appears to be no solid substance to replace it. Again the nation will be the ultimate loser if these space technology goals are lost because of an ineffective defense of their validity.

Now, to give the American people further wonderment over what load of people they have governing them, comes the episode of the Sarnad satellite (see p. 28) where the launch of a purely scientific satellite and the results therefrom were kept secret for months by Administration scientific advisers. This certainly looks like another clumsy attempt to conceal bad news about the effects of a basic technical miscalculation. Perhaps the men who tried to keep these results secret will eventually come forth with a more cogent reason for this cloak and dagger technique but the odds are against it.

As the Administration flounders toward 1964 and its day of reckoning at the polls, it can look back on an incredible trail of political, technical and moral wrongdoing that will leave even its most ardent supporters wondering how it all could have happened under the increasingly brilliant promise of inauguration day.

—Robert Harts





Fluxus Monitor System built by Texas Instruments and utilized by Navy Command, RADM Program Manager.

## TI ELECTRO-OPTICS... seagoing solution for tracking accuracy!

This new Texas Instruments Fluxus Monitor eliminates significant radar antenna data errors created by the bending and twisting hulls of missile-tracking ships. Accurate to two seconds of arc, the system uses a beam of light to carry alignment data in three axes—vertical, lateral and twist—over 50 and 100-ft distances. The unique TI solution for twist measurement makes possible a simple, rugged, practical system free from envi-

ronmental problems. TI applies this same blend of electro-optic skills to laser navigation and alignment problems for the Polaris submarine, Minuteman silos, Nike-Zeus acquisition radar, and other programs. Capabilities for custom solutions to electro-optic problems are but a part of TI's overall systems engineering effort. Your systems program can benefit from these and other TI creative engineering capabilities. Write department 48,



**TEXAS INSTRUMENTS  
INCORPORATED**  
8000 LEMON AVENUE  
P.O. BOX 6015 • DALLAS 22 TEXAS

APPARATUS DIVISION  
ELECTRONIC  
MICROFILM DIVISION

## WHO'S WHERE

### In the Front Office

Thomas F. G'Neil, second chairman of General Tire & Rubber Co., elected a director of Aerojet General Corp., Azusa, Calif., a subsidiary of General Tire & Rubber Co.

Dr. James Earl Riddle, president of Texas A. & M. College, elected a member of the North American Corp., Bethesda, Md., an executive John F. Conway, retired.

Dr. Glen Sawyer, C. George (GCAF) will vice president of American Motors & Foundry Co., second director of the AAFI-Chrysler-Song-Silverstein research control device program, Los Angeles, Calif.

Kenneth A. Ray, president, Space and Air, Inc., New York, N.Y., succeeding Ralph C. Ray who continues as board chairman. Elected vice president, T. J. Mullin, project engineering; Dr. S. Eason mechanical physics and aerospace engineering.

Dr. Chauncey W. Sherman, vice president and general manager of Armstrong Corp.'s Laboratories Div., will become Deputy Director of Research and Engineering and Research and Technology Department of Defense, as of June 1.

John Deere Manufacturing Co.'s Austin D. Rimmer, who has sponsored the last listing in our previous, R. G. Hinkle manufacturing, J. M. Rimmer engineering.

Donald Stoddard, vice president and general manager, American Airlines of Mexico introducing a Southern Airlines wing.

Stanley L. Eason, president, Hillco Corp., has appointed Vice President, D. M. Stuart to the Washington D.C. office, to coordinate the company's activities in and with the defense, J. B. Warrington, elected vice president of Hercules Electronics Div., introducing VLSI Stuart as general manager of the Federal Development Group, Indianapolis, Ind., and G. B. McClellan, assistant vice president.

Dr. Donald W. Galt, vice president, Calhoun Company Products, Inc., Anaheim, Calif., will continue as the company's chief engineer.

Amcor Corp., a subsidiary of The Electronic Corp., Los Angeles, Calif., has appointed the following vice presidents: Joseph J. Davis engineering; Robert L. Frazier chief selling; Paul H. Hinkle administration; M. J. Van V. W. Hinkle administration.

Short H. Smith, vice president and in recent months, 562 Industries Inc., Philadelphia, Pa., and Thomas F. Sherris, vice president, Philadelphia.

R. G. Johnson, vice president/finance, former Secretary General of General Electric, Inc., Cleveland, Ohio.

Robert J. Murphy, vice president of the Boeing Co., has been appointed manager of the "Quadrangle" D.C. office, replacing Clifford E. Ketchum whose new appointment will be announced.

J. P. Whitten, vice president and general manager and Dr. John P. Noll, vice president and assistant general manager of Los Alamos and Development Division of Los Alamos & Spies, Co., Sunnyvale, Calif. Dr. Ray A. Smith will succeed Mr. Whitten as vice president and general manager of the Space Programs Div.

(Continued on page 12)

## INDUSTRY OBSERVER

► Morton Orlando's winning proposal for development of Aerojet's Sprint high-speed, solid-state, variable specific impulse, variable thrust rocket engine is first of the Aerojet Polaris. G-10 will build the engine from the side for gas turbines at the Aerojet Sprint will be built in small and large, high performance motors built with Hercules Powder Co.'s fast-burning double base Class 9 propellant.

► Second North American X-15, which crashed last November, will be rebuilt as a hypersonic research vehicle by the Air Force. One mission will be to test external swept engine for supersonic plane concepts. External tanks will be added to increase rocket engine burning time by more than 1 min., boosting top speed from Mach 6 to about Mach 8. NAA's Los Angeles division will rebuild the plane.

► USAF Space Systems Div. election an use of General Dynamics/Astro-nautics Atlas Mark 2 as a space launcher is reported early next month. Vehicle would transport about 4000 lbs. of payload around a world orbit. Using liquid oxygen and RP-1 fuel, it could carry a 20,000-lb. payload into a 100-min. orbit. The performance would be improved 20% in a 100-min. orbit. On all length of vehicle's thrust payload would be about 50 ft., and diameter would be 10 ft. Atlas F is 70 ft. long, has 104 ft. diameter.

► Aero 748 design team has submitted two jet versions of the transport to Hawker Siddeley Group board of directors for consideration. One design features aluminumized fuselage, the other uses polished metal under the pressure wing. Both versions make maximum use of the Aero 748 wing and fuselage. Hughes is intended to compete with the Fokker F-28 and the Hawker Page Jet Herald.

► McEve's rocket guidance system being developed by General Precision for the variable medium-range ballistic missile will be flight tested aboard a Lockheed Polaris missile in part of the nation's flight launch program. MGRM guidance will ride piggy-back on Polaris, with its control system transferred to ground stations.

► Short Bros. and Harland, Norfoll, Norfolk surface maintenance, is tooling for about one-third of the aircraft work on H. Vickers VC-10 jet transport for the Royal Air Force. Splitting work between Vickers' Westbury and Harland will add about \$3 million to the job cost of about \$44 million, but British government has accepted the costs to help maintain employment levels in the Harland area. Extra charges will be written off on the RAF budget.

► Bell-Aerochem is developing a technique for diverting liquid-propellant rocket engines and still obtaining better combustion and control of engine temperature. Bellchem is in Seattle and from two principal reactions, one water-rich and one fuel-rich to separate combustion chambers, balanced in energy and burning the two elements in the main combustion chamber.

► North American BS-70 has an automatic engine restart system to minimize engine damage caused by sudden engine flameouts from shock inputs or other causes. Cycle times about 5 sec. to restart the engine. One example of a typical disturbance: if the thrust were to be expelled from one of the two engines, the pilots would experience a lateral acceleration of 0.3 g due to the differential drag.

► Program for Aerojet's defense system for 1970 (AAM-70) is planned as a two-year test. First phase will be three-month technical feasibility studies in which contractors, limited at about \$100,000 each. Second phase will be three-month systems development effort for two contractors about \$200,000 each. Third phase will be a hardware system development in which contractors, involving a cost of about \$300 million and beginning in the middle of 1964. Industry proposals in competition are due Apr. 22 and thus, contractors are expected to be selected within a month.





## In Space Electronics and Avionics, strength favors General Precision



...strength based on these design/development/production achievements of General Precision's Information Systems Group. • First digital computer to perform bombing and navigation functions in attack bombers of an operational Navy squadron. • First digital computer developed to guide an exploratory instrument package (Gestalt) to a soft landing on the moon. • 1.90 general-purpose digital computer, combining the fastest operating speed, lightest weight, and largest memory capacity ever developed for use in aerospace systems. • Navigation/data processing system for C-141, the first turbofan military transport for global airlift. • On-boarders of E2W fighters, stage separation, and thrust termination devices. • Send for information from LIBRASCOP DIVISION

**GENERAL PRECISION**

INFORMATION SYSTEMS GROUP  
800 Webster Ave., Glendale 1, Calif.



## Washington Roundup

### NASA Budget Cuts

House space committee may cut National Aeronautics and Space Administration's \$5.7-billion Fiscal 1964 budget request by about \$280 million—\$115 million from the manned flight program and \$165 million from other areas.

Sen. to space committee, which is to begin authorizations hearings on NASA's budget on Apr. 22, intends to take a closer look than it has in past years, chiefly because of the increasing demands for economy in government.

Rep. Joseph Keith, chairman of the House subcommittee on space sciences and advanced technology, announced the decision of Congress in trying to determine what is absolutely necessary in NASA's budget. He told one witness:

"We would like to help you, if you think you need help. I find it very difficult to find areas where we should reduce, because an answer is not what the budget request is, [NASA officials] will defend it to the last breath in there, and when we try to help ourselves. I find it is extremely difficult to do this, too. I am not sure we can accomplish either of these goals unless we get some of the information we request."

### Gilpatrick's Successor

Paul H. Nier, assistant secretary of defense for international security affairs, is considered the most likely candidate to succeed Deputy Defense Secretary James C. Gilpatrick with William P. Brady's deputy assistant secretary—moving into Nier's spot. Nier's strong background in international affairs which includes direction of State Dept's policy planning staff would supplement Defense Secretary Robert McNamara's limited experience in the field at a time when closer coordination between Defense and State Dept. efforts is needed. Brady is a brother of McGeorge Bundy, the President's special assistant for national security.

With his Lawrence L. Korman, special assistant for space in the director of defense research and engineering, to leave his Pentagon post in the near future.

Joint Chiefs of Staff have given all unified and specified commands one month to study ways to reduce expenditures which adversely affect the U. S. balance of payments. The studies could result in cutbacks in spending for overhead of aircraft and other equipment outside U. S. borders, reduction of aircraft bases and cuts in the number of dependents overseas.

### Sic Transit Gloria

Science and accompanying missions have decreased over the Transit navigation satellite program. Until last week, Transit had not been covered by Defense Dept. Information 578013, which reports activity on the project names of all active space programs except the Air Force X-20 and the Defense Dept. NASA's satellite. Some Navy officers are questioning whether the success order will prevent one of open Transit satellites to commercial shipping. NASA, which signed a joint Transit development agreement with Defense Dept. last last month and it does not know the effective effect of the success order, but said Navy has indicated that the civilian use will be removed when the system becomes operational.

Critical Gemini review meeting was held Apr. 11 by NASA to analyze launch schedules become development changes, and to determine the sophistication of the first flight schedule. Question is whether the first shot, a ballistic test, should be a "two shot" to qualify the Titan 3-Centaur configuration or a non-rated capable to qualify systems as well as design.

General Accounting Office is urging Defense Dept. to place procurement and management of aircraft engines and associated supplies and equipment under centralized management. A comprehensive Defense Dept. study to determine if and how this can be done is due for completion in October. It covers 13 classes of equipment including 150,000 different types of items costing about \$6 billion.

### In TFX Circles . . .

Scientists investigating the TFX contract award (see p. 28) are having their heads trying to understand some of the technicalities. Sen. Edward Brooke said: "I have been on many many ground-works on these hearings than I have been ever before in my life." He told one witness: "You fellows could draw a line or even with some of these words or terms."

Sen. Karl Mundt was even more eloquent. He said to John George Anderson, chief of naval operations: "On page 6 you say among the various qualities that appear to radiate Boeing to be a more reasonable and effective plane. Its accessibility for electronic maintenance was his top priority. That might be true, but it is not in the line of the far as I am concerned. Can you tell us what the [Boeing] it means?" John George Anderson explained that it meant it was easier to work on the [Boeing] plane. "I know exactly what you mean," Sen. Mundt said, "because my son Charles' automobile has left and right signal radiator huddles on the dark to red I cannot find them with a flashlight in high noon. I am in favor of having these ground-works up where you can find them."

—Washington Staff



# Wiesner, Charyk Ordered Stared Secrecy

USAF satellite's discovery that Starfish radiation may last 10 years proves embarrassing to Administration.

By Larry Bonds

Washington—Evidence of the unclassified scientific satellite Starfish, designed to measure contamination of the ionosphere, was kept secret until recently on orders of former Under Secretary of the Air Force Dr. Joseph V. Wiesner. Its politically embarrassing finding that radiation produced by the U. S. Starfish high-altitude nuclear explosion last July 9 may last at least 10 years also was kept under wraps, by order of Dr. Jerome H. Wiesner, science adviser to the President.

First general information based on Starfish's observations—that radiation within the magnetic shell in which Starfish was fired is considerably higher than the level prior to the shot—was revealed at the Air Force Cambridge Research Laboratory on Apr. 5. Details will be given in four scientific reports before the American Geophysical Union meeting here Apr. 17-20.

Starfish also immediately detected unusual radiation from Russia's high-altitude nuclear explosion fired last Oct. 28 and Nov. 1. The satellite was placed in orbit last Oct. 26, two days to measure the effects of the Oct. 27 Russian shot.

Starfish (the Starfish satellite) was a heavily assembled package of sensors and instruments prepared for flight in a Lockheed Agena D space vehicle after Air Force officials convinced Administration officials that they could carry a satellite payload in orbit quickly by using standard components.

Starfish was approved because of a desire to provide a backup to the Explorer 15 satellite of the National Aeronautics and Space Administration.

## Stared Launch

Starfish was launched by a Douglas Thor booster from Vandenberg AFB, Calif. Launch weight was 170,000 lb and apogee was 5,812 mi. Inclination was 71.41 deg. Starfish transmitted until Jan. 15 when its batteries were out.

Starfish was the only satellite to track continuous information on the ionosphere level occurring from Starfish and the two Soviet shots. Explorer 15 was placed successfully into orbit Oct. 27 but failed to descend. It continued to orbit at 50 km instead of descending to the intended 60 to 80 km. Then, only wide-angle observations were possible.

Starfish was designed to make orbit at as readings along the magnetic shell that lies at a geomagnetic altitude of L=1.25. L=1.8 is the outer edge of the earth's magnetic equator. The outer magnetic shell L=1.25 lies 0.25 earth radii above the earth's surface at the magnetic equator, but lies closer to the surface near the poles, where the magnetic lines of force converge.

Starfish was exploded in the L=1.11 magnetic shell. The Russian shots, fired

the readings of Oct. 27. By Nov. 4, the readings had dropped almost to the Oct. 27 levels.

The U. S. at one time had planned to fire at least three thermonuclear devices at high altitudes last year. The latest device broke the outer Van Allen belt, a hollow donut within the main belt, and a magnetron device in the center.

An international scientific controversy over the contamination that these shots would have in space began even before the first shot was fired. Falsely alleged the attempt to launch the first device, to altitude, due partly to the lack of such data. This however—some of them from ionospheric soundings—was also widely adopted for the mission.

For reasons that have never been announced, the L-4 ionosphere Starfish device was exploded at 250 mi. over Johnston Island in the Pacific Ocean. The main belt is created in a collision belt and enhanced the ionosphere in the main belt.

## Wiesner Position

Dr. Wiesner, who originally had advised the President to go ahead with the high-altitude shots in spite of the controversy, is understood to have wanted at least one successful explosion in the belt to measure effects on communications. His position was that there would be no lasting change in the natural environment. That opinion was supported by Dr. James A. Van Allen of Iowa State University, who found the natural ionosphere belts are renewed.

Dr. Van Allen, who the Oct. 25 Russian shot increased the radiation by a factor of two for three hours, having merged those four million electron volts. At lower energies, about 10,000 electron volts, the effect was 10 over.

## XB-70A Rollout

Rollout of the experimental XB-70A has been postponed to late May or early June and test flight could be as early as July or no further difficulties are encountered. Rollout had been scheduled for late this month, after final tank test problems had been solved. The rollout is scheduled for December (AVS Nov. 26, p. 35).

Tank testing probably will be finished by middle of May and wing technology testing will begin in some tank testing pits completed. Some modifications at wing and fuselage have been indicated. A pilot built, or at least tested, model of this one, and modified standard model after that conventional aluminum alloy construction rather than composite alloy most probable.

of unobtainable information. Starfish's initial findings were quickly incorporated into its placement and use, but there were long secret. Experiments were:

- CRIM-2—quasiparticle spectrometer, developed by F. Paulsen and R. Casanova of American Science and Engineering Co. and S. K. Saito and R. S. Sweet of Cambridge Research Laboratory. It measured the proton spectrum above 0.5 million electron volts and carried out particle type and energy analysis.

- CRIM-1B—beta-particle spectrometer, assembled by the same team. This spectrometer carried four scintillation counters, two of which were shielded for 14,000 electron volts and the third for 4,000,000 electron volts. Each measured the total energy deposited.

- CRIM-2—electron solid-state spectrometer, S. Bloom, R. West and L. Mares of the Lawrence Radiation Lab, University of the California. This spectrometer utilizes 100-deg. cone, focusing, double-crystal silicon electron lenses into five energy channels, centered about 125,000, 395,000, 1,618,000, 2,440,000, and 3,250,000 electron volts.

- DEC-3—large electron detector, R. Clark, of the Air Force Special Weapons Center contracted two 2-in.-diameter ionospheric observation chambers whose walls are covered with a plastic.

The intense competition of the plastic scintillator against the silicon ionospheric electron counter provides data on radiation dose.

- CRIM-24—total energy detector, assembled by R. Smith and W. Isenberg of the Nuclear Physics Laboratory, University of California, Berkeley. The satellite was carried. Three of them had thresholds of 1,000,000, 2,000,000 and 4,000,000 electron volts. They are used by plastic scintillators. The silicon counter of 1.5 in.

- CRIM-20—total energy detector, assembled by P. Dial of the Special Weapons Center. A solid-state detector measures electrons from 20,000 electron volts to 1,800,000 electron volts and produces the same penetrating power.

- CRIM-20—scintillation spectrometer, used, same as the two experiments. A single thick scintillator surrounded by a steel shield consisted of a 1-in. diameter 600 lb. diameter, 10 mm. proton and pulse analysis in series (see below from 1 to 70 mi).

- RF-2—magnetron probe, assembled by G. C. Henschel of the University of Utah, and J. C. United, of the Cambridge Research Laboratory. A 20-MHz magnetron was used to measure electron density by detecting changes in impedance in the ionosphere.

- SEE-3—solid-state semiconductor spectrometer, R. E. Fuchell, Applied Physics Laboratory, Johns Hopkins University. The performance of various types of solar cells and transistors in the belt

# Defense Wants Comsat System With 24 to 30 Satellites by 1965

By Alfred F. Albano

Washington—Defense Dept. will set out in May or June on a satellite communication satellite program based on a goal of putting 24 to 30 operational satellites into orbit by 1965.

John H. Rabel, deputy director of defense research and engineering last week told the House, space subcommittee on applications and tracking that the program would require 10 to 15 satellites, and would require 10 to 15 satellites, and would require 10 to 15 satellites.

The Defense Dept. system, which will cost an estimated \$200 million to \$250 million, will be developed jointly by the Air Force and NASA. The Air Force is responsible for all space-related matters and the Army for ground station.

W. William F. Rabe (D-N.Y.) urged Rabel to "come to a clear understanding with the Communications Satellite Corp. that the government at least has some preferential title" for the system.

He also said that the government is responsible for an important part of the corporation's development and operational activities.

Regarding Defense Dept. communications program, Rabel and the Air Force have been working on the joint package of Project Wooten, which would place 24 to 30 satellites in orbit.

He said the system would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites.

He said the system would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites.

He said the system would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites.

He said the system would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites.

He said the system would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites.

Rabel's testimony last week, attempted to answer most of these questions. He said the system would be based on utilization of the demonstrated technology of Comsat, Telstar and Telnet, and that work done on the satellite system for the Soviet world was applied to design of the tele for the new medium-altitude satellite.

Other requirements that could not be included by commercial users, he said, include "personnel, reliability, security, ECM (electronic countermeasures), maintenance, and military control of comsat hardware."

The Defense Dept. system, which will cost an estimated \$200 million to \$250 million, will be developed jointly by the Air Force and NASA. The Air Force is responsible for all space-related matters and the Army for ground station.

W. William F. Rabe (D-N.Y.) urged Rabel to "come to a clear understanding with the Communications Satellite Corp. that the government at least has some preferential title" for the system.

He also said that the government is responsible for an important part of the corporation's development and operational activities.

Regarding Defense Dept. communications program, Rabel and the Air Force have been working on the joint package of Project Wooten, which would place 24 to 30 satellites in orbit.

He said the system would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites.

He said the system would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites.

He said the system would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites.

He said the system would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites.

He said the system would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites, which would be made of 24 to 30 satellites.







## TFX Thrust Reverser Cost, Weight Cited

Washington—Fate & Whitcomb estimates that installation of thrust reversers on the proposed General Dynamics-Grumman F-111 (TFX) fighter would add 900 lb to each engine and cost an additional \$400 million for the entire expected order of about 1,700 aircraft. Research and development costs would be \$12.7 million additional for Pratt & Whitney versus costs for the entire thrust reverser project.

Donald J. Jordan, chief engineer at Fate & Whitcomb, says these amounts will be "while French fighter the Boeing General Dynamics Subsonic Technology Development (TFX) contract would be General Dynamics-Grumman. The General Dynamics design calls for no inlets and nozzles, while the Boeing proposal isolated thrust reversers. Defense Dept and General Dynamics are now exploring the possibility of placing thrust reversers on the General Dynamics design (AW Apr. 8, p. 28). Navy already is concerned about the weight of the F-111 design. Jordan and the Boeing-type reverser would weigh 500 lb per engine, or 1,000 lb per aircraft, but a more limited reverser for deactivating the aircraft once it reaches down would weigh about 100 lb. The net weight increase from the reverser would be their weight minus the air intake and nozzles in the current General Dynamics design.

Fate & Whitcomb stated in the \$420 million cost estimate by listing reversers for 7,400 engines for each of the 1,700 aircraft, plus 25 percent for installation of the test gear for the reverser at \$300,000. This compares with Boeing's last unit cost of \$14,500 for the reverser at the start of production, with the possibility of reducing this to \$9,500. Reversers were installed in Boeing's last lot of the F-111 contract. Defense Secretary Robert S. McNamara has said Boeing's cost estimates generally were unrealistic. Cost of the thrust reversers on the Douglas DC-4 is about \$95,000 each.

weight almost throughout the world."

■ **Deal wheels.** Jordan proposed that wheels, two on each side of its landing gear, with General Dynamics proposed a larger single wheel on each side. Gen. Dynamics said that wheels would be able for landing and takeoff in situations. ■ **Air usage.** Gen. Dynamics said General Dynamics placement of these to use the aircraft being carried under the aircraft might cause a thrust as the engines required exhaust from the aircraft as it was being carried. ■ **Ferry usage.** He said other advantages of the Boeing design was the longer ferry range and greater maneuvering ability.

In discussing the general capabilities of the competing contractors, Gen. LeMay said that "going back to the original proposal, the Boeing team had a much better knowledge of what was required in this sort of an airplane. They had a more flexible system, better about I think, to produce it, and cost forward with a much better proposal. Then did the General Dynamics team. The contract was given to Gen. LeMay (Gen. LeMay) (D. W. H.) after the late evaluation of the F-111 held the lowest-priced proposal of General Dynamics catch up to Boeing's higher bid cost.

Gen. McKee, in a memo statement filed with the administration Feb. 21 and discussed Apr. 5, said "There was no choice within the Air Force Council [at its meeting Nov. 5], including the Navy members, to not choose the Boeing proposal. The Boeing proposal was the 'most expensive' of building two completely opposite prototypes. He said 'There are certain advantages to a comparison of this

kind," and added that "this is the only the Russians do the business."

Adm. Anderson and in his prepared statement that the McDonnell T-45 will be light tested against competing aircraft before it goes into quantity production and "the end result was the final aircraft of its type in the world today." He said the "true merit" of the F-111 "was only, however, when there is available to such aircraft an actual flying machine on which flight evaluations can be accomplished by qualified test personnel and when it is combined with a suitable missile system."

The Senate subcommittee now led by Boeing and General Dynamics to estimate how much it would cost to build fully equipped prototypes which could be tested against each other.

Washington said that the Defense Dept. had decided to incorporate to carry of the superior features of the Boeing proposal into the General Dynamics design as possible. "Undoubtedly," Gen. LeMay said, "we will try to apply the good points that we found in the Boeing design as far as we can to the General Dynamics design to that we can produce the best possible airplane."

In this connection, Sen. Mansfield told Adm. Anderson: "If what you come up with ultimately is a Boeing plane with a General Dynamics label and a General Dynamics prop tag on it, so be it. You probably will have to move in the direction of improving it, and you would have done the same. I can see, had the Boeing design been selected," Adm. Anderson replied. "That is correct, sir."

## Large Solids Contracts

Washington—Thiokol Chemical Corp. was expected to win the major share of Air Force large solid propellant solid rocket development contracts. Thiokol was expected to be awarded package 2, static firing of a 1 million lb. thrust, 150 sec. burn solid rocket motor, and package 1, demonstration of a 1 million lb. thrust, 160 sec. burn solid rocket motor. Thiokol and Aerojet-General Corp. are expected to conduct parallel developments for 160 sec. burn solid rocket motor, and a 1 million lb. thrust solid rocket motor for package 1.

Lockheed Polytechnic Co. was expected to win bid package 4, testing for dynamic strain rate of a 1 million lb. thrust, 150 sec. burn solid rocket motor.

Some selection based on communications (AW Apr. 8, p. 28) was believed to have been accepted only for package 1. The board recommended Aerojet for package 2, Lockheed for package 3 and Lockheed Technology Center for package 4.

## Japan Early Warning Competition

Tokyo—Japanese Self Defense Agency has asked General Electric, Hitachi and Hughes—the three major companies building an early warning and air defense control system for Japan—for a third round of proposals in the competition.

Companies had submitted proposals before before but in each instance the Joint staff agreed delivery was too slow (AW Mar. 4, p. 28). The program, to meet needs and implement the existing missile and radar systems, is based on a semi-automatic complex assembling a multi-Sgt. system, but been under study since 1959.

Contractors are required to deliver their latest bids by Apr. 27 and Japan is expected to make a final decision by the end of May. The Japanese estimate that an early selection will save the cost for acquisition of U.S. funds in the Fiscal 1964 budget to help build the system in Japan.

Report says only for a smaller system than previously considered. Second system definition was based on a projection of the system handling up to 500 targets in 1967. Current Japanese thinking is that this figure was exaggerated because the number of aircraft will decrease, by several estimates, to 500 by 1975. Third estimates, therefore, will be designed to handle 300 planes, although Japan expects to have more than 300 aircraft flying during the system period before 1970.

Specifications given by the defense agency for the third configurations are more stringent than those for first two configurations. Presently, the defense agency specified the number of radar sites, number of its plans to be controlled and number of many plans expected. It then asked companies to develop a system to meet these requirements. Now the defense agency has also included specifications on the radar itself.

Japanese government also specified that the Japanese portion of the American company winning the competition will be expected to sign a contract with a first year for the system installed at the radar sites and covering. First year is expected to permit radar system used in three operations under a \$100 million, when equal amounts were estimated after five years.

Defense agency has greatly motivated its position. First phase called for a system design contract, to be followed by a production contract. Present phase will focus on system design and production contracts simultaneously.

Funds have been set aside for the system itself for the program. About \$35 million has been planned for the system itself, the second five-year delivery build-up program (1962-66). There was disagreement within the defense agency whether the money should be used to equip only one of the three new sites which the nation's defense system is divided, or to equip all three. The Japanese now have decided to develop the system for the whole country.

## Britain Will Pay 'Normal Costs' Plus 5% for U.S. Polaris Missiles

Washington—Great Britain will pay "normal costs" for U.S. Polaris missiles and the support system, but will not cover part of the research and development costs incurred after Jan. 1, 1959. A technical agreement signed by the two countries on Apr. 6 contains details of the basic agreement, and the President John F. Kennedy and British Prime Minister Harold Macmillan last Dec. 27 at Nassau (AW Dec. 24, p. 28).

Britain will receive the 1,500-unit or more Lockheed-developed A-3 model Polaris, minus the warhead. The agreement specifies that these warheads will be furnished. The agreement specifies that these warheads will be furnished. The agreement specifies that these warheads will be furnished.

Britain plans to build four nuclear-powered submarines, each armed with 16 missiles. It will purchase 64 missiles, plus the warheads, from the U.S.

Total cost to Great Britain of the Polaris submarine and missile program is expected to be \$1.5 billion. The agreement specifies that these warheads will be furnished. The agreement specifies that these warheads will be furnished. The agreement specifies that these warheads will be furnished.

sign development production, test or other engineering services required.

Additional associated support, test and training equipment and services. These include test and checkout equipment, specialized power supplies, power distribution system, construction spaces and main parts and industrial structures, including engineering, maintenance and assembly. Use of training and main range facilities will also be furnished.

Information about the hull, auxiliary machinery and equipment of U.S. Polaris submarines will be furnished, but the agreement specifically excludes information about the nuclear propulsion plants of U.S. submarines.

## Navy's Role

Missiles and equipment will be fabricated in the same documentation and quality standards as in the U.S. Polaris program. Production schedules will be coordinated with the U.S. program.

The Navy, acting for the Defense Dept., will be executive agent for the U.S. government in the joint program. The Admiralty will represent the British government.

The U.S. project office probably will be based at J. J. Galtieri, director of the Polaris support project office. Rear Adm. H. S. Macmillan, chief Polaris executive for the Admiralty, is expected to be named project officer for Britain.

A joint steering task group will also be formed, composed of project officers and liaison organizations. It also may include scientific, industrial and government executives from both countries.

The agreement protects patent and proprietary rights, and holds the U.S. not responsible for nuclear hazards. Security measures are also defined.

According to the project office, Great Britain expects to have its first Polaris submarine operating in 1968. The A-3 missile is now being tested and will go into production early next year. The first U.S. submarine armed with Polaris missile will be deployed in mid 1969.

## Military Space Studies

Series of studies designed to explore various military aspects of space is being prepared by Air Force's Space Systems Division. The study is being prepared by the Air Force's Space Systems Division. The study is being prepared by the Air Force's Space Systems Division.

One of the first in the series will be to determine the military potential and weaknesses of space. Another one will be a technical comparison of current military space programs and a study of the future. The series will not be tied to any specific vehicle or concept.



# Contractor Evaluation Comments Asked

Washington—Details of the Defense Dept.'s new contractor evaluation program, in which companies' past performance on major developmental projects are scored to provide criteria for selecting contractors for new projects, have been sent to the individual military departments and to the House Defense Industry Advisory Council for comments (AW Feb. 8, p. 8).

Defense Dept. hopes to introduce the new contractor performance evaluation plan by July 1. National Aeronautics and Space Administration, which participated in preparation of the rule-making system, currently is preparing revisions to the plan from its concern about introducing the system into NASA programs.

The proposed procedure sends the rule of conduct to companies, ratings of individual contractors, and no black list of "undesirable" contractors is planned.

The system will provide a full range of factual measures of each contractor's performance in meeting his contractual commitments on each major program in terms of technical performance, cost and schedule.

Development contracts involving in excess of \$1 million are expected to include contractor performance audits at the conclusion of the project. In addition, contracts whose annual funding exceeds \$5 million or whose total program value exceeds \$20 million will require audits at five-month intervals, according to present plans.

## Initial Performance

The military project manager will prepare the initial performance evaluation, which will be sent to a central evaluation group of the military department involved. If the report is a noncommittal one, the evaluation group will have the option of making an independent field investigation with its own team of technical, procurement and legal experts.

If the program is completed, an independent field audit is mandatory under present plans.

The evaluation report then goes to the contractor involved for his review and comments, if he disagrees with its content.

These comments become a permanent part of the record.

The report next is returned to the project manager for his review and comments on views reported by the contractor and central evaluation group. The report then returns to the central evaluation group a second time, and the group has the option of making another field investigation in the event that

there is a sharp divergence of opinion.

The procedure is aimed at creating a system of checks and balances which minimizes the possibility of an unfair appraisal.

The complete report, including all project manager and contractor comments, will then be filed, and will be available for use in evaluating bidders in subsequent competitions. For example, if companies "X" and "Y" are finalists in a subsequent competition, with proposals comparable in all respects but price, and if company "X" scores a cost which is 20% less than company "Y," the past performance records of both companies will be withdrawn from the file and analyzed.

If both companies have a consistent record of advancing contractual performance requirements, reasonably on schedule, but company "X" consistently overruns its contract cost estimates by 40% while company "Y" normally meets its cost estimates, this might provide the basis for awarding the contract to company "Y."

## Major Programs

The major development programs, most of which are structured on a cost-plus-fixed-fee basis, have been a strong temptation for bidders to do work anywhere in meeting out, time and performance in their contracts to get the job. Even with cost-plus-incentive fee, first evaluation, there is a tendency to "pioneer the moon" to get the job.

The new evaluation system is expected to provide a non-biddable cost incentive to this situation, according to Robert Tucker, assistant director for on-

going management, officer of the director of defense research and engineering. Tucker's office is responsible for preparation of the plan.

The plan proposed is a "flat scored rating system," Tucker said, intended to minimize in as much as possible the differences between individuals involved in evaluating different programs. Furthermore, it seeks to answer the question: How well did the contractor perform what he agreed to do, in terms of technical performance, cost and schedule?

The evaluation records will show the original contract terms as well as any modifications introduced by subsequent change orders.

The records will show also whether these change orders were requested by the government or the contractor to cure his commitment.

For contractors who are eager about the new Defense Dept. evaluation system, Tucker offers the following advice: "Don't promise more than you know, don't think you can do and if you get the contract, accomplish what you promised."

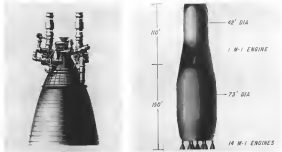
The proposed performance evaluation system will send Tucker emphasized, require an additional paperwork as reported by contractors beyond what now is required. Nor should there be a significant increase in the workload on a military project manager, primarily because he is doing a good job now of managing his program.

## Performance Data

The data on performance, schedule and cost reported for the month-long program reports are large programs in the most kind of information a project manager should always be obtaining and analyzing, Tucker said.

Because the new plan will apply sharp pressure on contractors to make more realistic commitments, it will also require military project managers to take up more realistic and well-defined work statements of what is required prior to selecting the contractor. That is another critical ingredient of the plan, according to Tucker.

For large contractors who have several major divisions involved in defense business, performance evaluation reports will be filed by individual divisions, so that each is judged largely on its own performance. However, Tucker pointed out that a certain amount of "corporate rat-on" may occur with adverse performance of a sister division. Perhaps it should be this way, he said, since corporate management must assume responsibility for all of its defense divisions.



M-1 light configuration, left, is 25 ft. high, 15 ft. across at its base. Two-stage turboshaft boost vehicle design, right, based entirely on M-1, would weigh 11.6 million lb., generate 37 million lb. thrust, and is expected to place 1 million lb. payload into 940 mi. orbit.

## Higher Thrust Potential Planned for Aerojet M-1 Engine

Aerojet-General's M-1 hydrogen-oxygen engine, designated in the upper-stage propulsion system for the Navy launch vehicle, is being designed for a greater thrust potential than its current rated value of 1.5 million lb., according to J. C. Moore, assistant M-1 program manager.

Aerojet also contemplates possible use of the engine in a booster for shuttles, upper right. As a booster, the engine would have a useful useful experience into that and in the upper-stage applications, the company says.

M-1 will be operated electrically and shut down by venting the gas generator valve and thrust chamber valve assemblies, which close the propellant valves by spring action. Shutdown assemblies will deliver gases into 100,000-psi. M-1 components will undergo tests beginning that fall. For heavy flight testing tests are planned for 1967, engine qualification tests flights in 1969.



M-1 hydrogen-oxygen gas generator injection assembly is shown.



Completed thrust chamber valve assembly for M-1 engine is shown at left. At right, an M-1 outgassing testing has been started for testing. Test facilities include hydrogen storage tank with 4.5 million lb. capacity, seven days' maximum production of all U.S. plants.





**SUD SA-130**, assault helicopter under development. It shows DLR's concept with proposed ducted fan anti-torque control system in the tail. Helicopter would have a crew of two and carry 12 soldiers.

## Sud Planning Twin-Turbine Assault Helicopter; Ducted Fans Possible

Margate, France—Sud Aviation's helicopter division is developing a twin-turbine assault-type helicopter, designated SA-130, which is scheduled to fly in 1965.

French army has indicated strong interest in the SA-130, originally designated the Alouette 3, but no firm order has been placed.

SA-130 will be designed to carry 12 troops and two crewmen. Gross weight will be five to six tons. Single rotor helicopter will be powered by two Turbomeca Bastan 7 engines, each delivering 1,800 shp. Cruising speed will be about 155 mph, maximum speed approximately 180 mph.

Sud engineers, at the request of the French army, are studying a ducted fan system as an attempt to avoid an anti-torque tail rotor layout. This would permit faster flight and improved ground load landing capability. Initial SA-130 prototype, however, is being built with a conventional two-bladed tail rotor. Single main rotor is fitted with four blades of 49.2-ft dia.

Sud plans to develop a helicopter version of the SA-130 as the Pave art show in June. The SA-130 could become operational in 1967.

New helicopter is provided with two side doors and a rear drop-door for quick access. Sud officials say the SA-130 will be an all-weather, high-capacity utility vehicle. Use of two 1,800-shp turbines is expected to give the helicopter a power reserve of 55% at normal weight and 65% at maximum weight.

Sud engineers acknowledge that the proposed ducted fan tail system would result in consumption of power in the

hover flight of three times that required by a normal tail rotor system. However, they expected the Bastan two-turbine layout to supply ample power for the flight regime, and that the tail fan system will afford a considerable gain in speed during flight.

French army is interested in the new tail system, as well as other features including a retractable landing gear, designed to make the SA-130 fast and maneuverable.

Sud's new helicopter design marks a continued effort by the company's main helicopter plant here to hold its important position as a helicopter manufacturer. Helicopter sales account for 20% of Sud's total business. To date, Sud has sold 1,521 helicopters and delivered 1,216.

Three sales include:

- **Dynas.** Sud built 150 of these two-plant turbine helicopters including 100 for military customers.
- **Alouette 2.** As of Mar. 15, Sud had received 661 orders for this five-plant, turbine-powered helicopter from 25 countries. A total of 416 Alouettes, 21 has been delivered.
- **Alouette 3.** As of Mar. 15, Sud reported orders for 121 of these seven-plant helicopters and 85 deliveries. Production of 210 vehicles is planned to date. Of the 121 ordered, 93 are for French military. The remainder are civil and export orders.

Sud's other helicopter production includes license manufacture of 160 Sikorsky H-14. The company also expects shortly to go into full-scale production of its 33-passenger Super Puma three-turbine, transport helicopter.

French military, civil, army, navy and air force—should result in production of 150 to 200 Super Pumas.



**NEW Guidance Duct, FC-101R**



**MURPHY SUPERIOR, APC LIFT CYCLE**



**MOORE Guidance Duct, FC-101R**



**MOORE CSE, F-101/105 Compressor**



**MOORE Fuel/Hydrolytic Oil Cooler**



**MOORE Fuel/Hydrolytic Oil Cooler**



**SPRUE Liquid Engine, UH-1H1 Exchange**



**MOORE Guidance Systems Cold Plate**



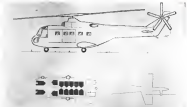
**MOORE Engine Lubricant Oil Cooler**

## THE HEAT'S OFF

Take the heat off your space project...and off yourself! Air-cooled to UAP. Our heat exchangers provide cool cores for French skyhook liquids, tanks and electronic components. Rockets, missiles, satellites—UAP equipment is new aboard many of the famous armies. And more are on their way. UAP has manufactured aircraft heat exchangers since 1929. We combine tried-and-true experience in heat exchange fundamentals with an eager outlook toward new challenges. This way you profit from outstanding product simplicity and reliability. But at the same time, UAP equip-

ment is built to your precise specifications, however demanding! For details, write...or phone 226-2641 today. UAP means United Aircraft Products. Since 1929 a dynamic, independent company in Dayton, Ohio. A name to remember when it comes to heat exchangers for space projects.

Get working arrangements for your heat exchanger.



**SEATING ARRANGEMENT** and general configuration are shown in drawing. Prototype will be built with standard tail rotor. Note ducted fan outlet in side view.



## LAMIFLEX—a new bearing concept

in the ENSTROM F-28 HELICOPTER



The MRC LAMIFLEX Bearing, latest addition to the MRC product line, is designed to move freely in one plane with an oscillatory motion while supporting extremely heavy loads in relation to the bearing size. Made of alternating thin layers of metal and elastomeric material, these bearings offer many advantages including: no requirement for lubrication... long service life... capable of functioning in presence of contaminants with no damage... ability to function as a seal.

MRC LAMIFLEX Bearings are now operational on the feathering axis and are specified for use in the flapping hinges of the Enstrom F-28 Helicopter produced by R. J. Enstrom Corporation. Moreover, MRC Elimination of troublesome daily maintenance and early replacement are immediate benefits resulting from the use of MRC LAMIFLEX Bearings.

Our local representative will be pleased to discuss application of LAMIFLEX Bearings in your product.

**MARLIN-ROCKWELL CORPORATION, Jamestown, N. Y.**



## McNamara Shifts Policy, Seeks Nuclear Power for Large Ships

Washington—Defense Secretary Robert S. McNamara, reviewing his earlier stated, now wants all future U.S. aircraft carriers and other surface ships displacing 8,000 tons or more to be nuclear-powered.

The policy switch was passed to the Navy's sea-based strike forces study group, which has been making a detailed study of their own defense and anti-air warfare, in addition to strike forces (AW Feb 11, p. 15).

The study group believes that a nuclear-powered carrier could be built for only 30% more than the cost of a conventionally-powered ship, by saving four nuclear instead of eight in the USS Enterprise. In addition, reactors are now more efficient than when the Enterprise was designed.

McNamara is currently withholding funds appropriated by the last session of Congress for the conventionally powered CVA 67. Vice Adm. Hyman Rickover, the Navy's nuclear power expert, convinced McNamara that nuclear power was logical and economical if properly applied (AW Mar 4, p. 21).

When the Navy was preparing its Fiscal 1963 budget request in the summer of 1961, McNamara directed that the replacement study be completed for the new ship. He believed it would be impossible to sell Congress on another 5,000-odd-ton carrier.

The Navy's policy now is to seek nuclear power for all coastal ships displacing 8,000 tons or more. This would include carriers, cruisers and more frigates. Navy Secretary Fred Kerley, in testimony before the Senate Armed Services Committee Mar 2, said nuclear power is "the prime study and consideration."

"Such conclusions," he said "might

the increased cost of these ships against their operational advantages and seek to strike a reasonable balance between the two, costly advantages and the overall requirements of ships to fulfill the commitments of the Navy."

Existence of the study group was confirmed by Adm. George W. Anderson, chief of naval operations, before the committee. "We have had a change going on for considerable time. This particular study arose because the Atomic Energy Commission asked the Secretary of Defense whether or not it would be desirable to develop a separate nuclear propulsion into the CVA-67 which was authorized last year. As a result of this we have had this

## IAM Prepares for Boeing Strike

Washington—International Union of Marine Workers last week was preparing to strike Boeing Co. facilities in 13 states. The union, based in Seattle, Wash., Workers was to be released from the 80-day no-strike provision of the Taft-Hartley Law Apr. 15.

The strike was set for IAM action when 57,457 Boeing workers, both union and non-union, voted on a final company proposal and rejected it by a 65% vote. Results of the election conducted by the National Labor Relations Board, was 11,141 to accept and 7,516 to reject.

The Boeing case marked the first time in the aerospace industry that a dispute has reached the critical "last offer" stage of Taft-Hartley. That stage, which during the 1950s to 1970s of the 50-day no-strike period. Within this 15-day period it is required that a final voluntary settlement proposal be put to a vote of all workers. If that fails, an extraordinary dispute between IAM and Lockheed Aircraft Corp. was settled on the 30th day of the 60-day no-strike period.

The union position on the Boeing case has strong national and local support (AW Apr. 3, p. 25).

National Confederation and Maritime Service, in a final attempt to avert a strike, started a 40-day negotiation—ending the Boeing dispute—properly after the NLRB announced the decision.

A statement by Boeing management on the decision commented that "it is significant that more than 35% voted for the company side." It added "the vote of the union-leased membership, the percentage vote for the union side, which more union members, along with non-members, voted a settlement

matter under review and under discussion with the people in the Dept. of Defense. In addition we are studying the whole sea-based striking force system which we expect to have completed for the Secretary of Defense in the fiscal which is closed by April 30."

The study now is expected to be completed by May 15.

Vice Adm. William A. Schenck, deputy chief of naval operations for the chairman of the study group. Graduate is furnished by a strong committee composed of Assistant Secretary of the Navy for Research and Development, James H. Wicks, Jr., Adm. Schenck, Vice Adm. Thomas S. G. Sharp, Jr., Adm. John B. Caldwell, and Maj. Gen. Edward W. Snodgrass, USMC. Dr. Alan Barrows, deputy assistant secretary of defense for research studies and his representative and Rear Adm. Thomas E. Caldwell, an ex-officio member of the committee.

and do not look with favor on the possibility of a strike." IAM has notified concerned 175 organizations among Boeing's customers.

IAM President Al Barnes said "Boeing employees, both union and non-union have made it perfectly clear that the company's offer is unsatisfactory. The next move is now up to the company. We are often amazed that the defense portion of the entire line would degrade an outstanding production at Boeing. We are well over all our responsibilities. Now we have a union-buster, postponed strike action at the request of the federal government, but also we have agreed to settle this dispute along with recommendations by the armistice board appointed by the President."

### Later Discovery

No technique for recovering hole output of a hole laser tube instrument discovered by the company in the early 1960s of a quartz crystal has been discovered by scientists at Kansas State Research Station, Kansas.

The new technique technique would be applied to measurements of laser beam output at longer wavelengths where previously used photodiode detectors have relatively low sensitivity. It might also be used to generate current in the semiconductor and semiconductor wave length range where present laser are extremely limited in power.

In IBM experiments, the output of a ruby laser was reflected back and forth through quartz crystal with reflective plates. The quartz crystal, when placed in the laser beam, produced a laser beam which was 625 angstroms long, causing quartz crystal to produce light at 2,964 angstroms.















Here's the only Jet  
now flying  
that can carry almost 50 tons of  
cargo or 189 passengers  
or any profitable combination of both  
over long distances  
at nearly 600 mph

## THE DOUGLAS DC-8F "JET TRADER"



The "Jet Trader" is not a make-shift cargo-passenger conversion. It is designed to be convertible.

Floors, doors, bulkheads and other structural members are engineered to handle heavy, bulky loads, while comfort and convenience features for luxury passenger accommodations are equivalent to those in the latest model DC-8s.

Cargo capacity for this aircraft is 95,282 pounds over intercontinental ranges. An extremely large cargo door allows loading over-the-counter containers. And a built-in, lightweight cargo handling system speeds on or off loading.

As an all-passenger aircraft, up to 189 persons can be accommodated.

There are 12 basic passenger/cargo combinations. Any of these can be arranged in less than 2 hours. Partitions are made for both bulk cargo and pallet cargo. Seats are track mounted for quick rearrangement. When cargo is transported, fold-down baggage racks protect the cabin windows.

The "Jet Trader" is available now for early delivery. It has been flying since November, 1962; has already been ordered by 6 airlines.

For detailed specifications, route studies, and performance information please address Mr. J. O. Moxness, Vice President Commercial Sales, Douglas Aircraft Company, Long Beach, California, U.S.A.



UNITED AIR LINE CARAVELLES are currently undergoing modification in San Francisco prior to service introduction on medium range routes in conjunction with Boeing 727s. Caravelle 1961 had fuselage width 19'6", equipped with United's 31.15m wide wing.

## United Plans Caravelle-727 Integration

By James R. Ashlock

**SAN FRANCISCO**—Caravelle aircraft of United Air Lines are being prepared to operate on medium-range routes in conjunction with all-first-class Boeing 727s, a plan which the carrier feels will reduce the French jet's operating costs through expedited utilization.

The Caravelles, which United officials acknowledge have been operating at direct operating costs (DOC) considered high for a twin-engine jet, are currently passing through their first major overhaul here. Twelve of the 20 aircraft have been overhauled, and the last will be completed about mid-July.

"The DOC on the Caravelles was \$772 per aircraft hour in 1962," a United spokesman told *Aerospace Week & Space Technology*. "We originally thought it would be about \$918 an hour, but that proved unrealistic."

He attributed the higher costs to short route segments, unexpected frequent engine changes and the special maintenance schedule drawn up for the Caravelles.

United feels the Caravelle will be a good partner for the 727, if new, has an edge. Like the Caravelle, the 727 will be an all-first-class aircraft, which can be backed up by the Caravelle to ensure schedule reliability. The Caravelle is expected to receive enough extra work in this role to improve its cash utilization.

Average stage lengths of the Caravelle are currently 434 mi. Its average trip time has been 1 hr. 12 min., with a daily utilization of 5 hr. 6 min. on an average of 4.5 trips per day. Daily utilization has peaked 5 hr. at peak periods. Hourly pay for the thirteen

engineers, who have 58 hrs. less on a United Boeing 720s and Douglas DC-8s in consideration of the Caravelle's lower gross weight.

The DOC will probably come down to around \$750 an hour with reduction of engine and refueling time between overhaul (TRO) and improvement of its service reliability. Tom J. Ruchart is expected to be the vice president of engineering and maintenance, and "But if we're expected to go on for as long as 30 years, the Caravelle as we are presently."

Despite its special problems, United feels the Caravelle has accomplished the purpose thereof when the first one was delivered in February, 1960. Although they are operated in all-India, which reduces loads on weekends, the Caravelle's load factor in 1962 was 57%, well above United's seven-mile average of 51.2%. The maximum payload was the last of an United aircraft, offering somewhat more than having the highest DOC in the fleet.

Caravelle has also enabled United to capture a good portion of the market in the competitive market between Chicago and New York. With them, United has a heavy schedule frequency into which the 727 can be integrated.

"The full potential of the airplane probably won't be realized until a year in work with the 727," Ruchart said. "There should be plenty of situations when it can be used for back-up or special section support."

Caravelle will continue to operate on their present routes after the 727s are delivered, but United expects to gain some extra utilization of the airplane by using it for a backup in extra section airplanes to the 727, in addition to its regular duties.

Caravelles have had to carry their own weight with United alone operating without benefit of jets to fill in for them when problems arise. Much of the on-line information has originated with the Rolls-Royce Mk. 551B, 3000 engine.

In June/July of last year, the 3000s were averaging 11 percent more aircraft a month, or about 28 per 10,000 hrs. of operation. Since then the average has dropped to near normal a month. But this is still well below the reliability factor of United's Pratt & Whitney JT4A-3 and JT3D-1 powerplants, which average less than five percent in annual engine work.

F. A. Prachand, director of engineering operations, explained that many premature engine overhauls were the



# Ship BIG with the Argosy...

## CAPITOL AIRWAYS CAN PROVE IT PAYS!



Capitol Airways, which operates Whitworth Gloster Argosy freighters to carry outsize and other military cargo on Logan routes in the U.S., now offers 98,000 lbs Argosy payload capacity for commercial charter. Consequently up to 8 ft. wide, 6 ft. high and 40 ft. long can be loaded at truck-bed height through full width doors at either end of the fuselage. With this easy handling, and jet delivery speed, Capitol can help you shipper your outsize cargo and cut distribution costs on many products. Just call Bill Leonard, Capitol's V.P. Sales at Nashville, Tenn., Alpine 6-5133, or write Capitol Airways, Berry Field, Nashville, Tenn.

The Argosy is built by Whitworth Gloster Aircraft Ltd., Coventry, England for

### HAWKER SIDDELEY AVIATION

30 Duke Street, St. James's, London, S.W.1,

U.S. Enquiries to: Arthur Norden, 551 Fifth Avenue, New York 17, Tel: OXford 7-3600

result of a peculiar "snoring stall" in the compressor action. Carlin blades in the 17 stage compressor would stall, with the stall then rotating around the section and affecting other blades. That touched off a vibration in the tail section and accelerated engine removal.

Spentair says that some of this problem came from United's special specifications for the engine, which called for the addition of the 17th compressor stage to bring the thrust rating up to 12,000 lb.

To correct the problem, United installed a 14-stage modification of the engine, about half of which have been re-worked. Carrier also asked pilots to maintain engine operation in the 5,000-6,000 rpm range—the area where blade stall occurred most frequently. The modification involved primarily the alteration of clearance and tension tolerances in the compressor action and changes to the variable inlet guide vanes.

#### Vibration Frequency

United is also checking each compressor blade for individual vibration frequency, among that such as within specified tolerances. That check alone has caused a rise in costs attributable to the engine, United officials said.

The ML 5318 on United's Caravelles is also the first of that series to be equipped with a thrust reverser, another of the carrier's specifications. Although the reverser has worked well except for some minor metal cracking, the maintenance of it has boomed costs above those reported by foreign users of the same engine.

United also experienced an excessive frequency of engine shutdowns initially, due to false fire warnings. This was averaging one or two a week—a high rate for any jet engine.

Caravelles were equipped with a Gruebler fire-warning system of European manufacture. United officials said the unit was overly sensitive to moisture warnings which touched off false warnings.

Using components manufactured by Peugeot, United redesigned a status system that included a reprogramming of sensors. The modification cut approximately 53,000 per airplane, but false warnings have been reduced to tolerable ratios.

Engine vibration also accounted a major strengthening of the tail structure, attachment during overhaul. Attack area bolts were found to have a limited fatigue life, and have been replaced by larger ones with no fatigue indication. Internal structure of the tail assembly has also been beefed up.

This was United's second round of success with the Caravelle's revised and somewhat troublesome. Even before the initial work arrived from Sud Aviation, United wanted that the tail assembly be strengthened against this crack-

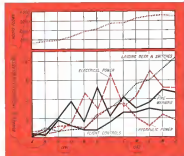


CHART REFLECTS THE major areas of mechanical complexities on United Air Lines Caravelles and frequency of occurrence during Fiscal 1968.

ing due to water intrusion. The surfaces were given an X-ray examination each 500 hr. during each operation, but this has been discontinued, since no damage became evident.

Two areas in which United anticipated difficulties, but which held up better than expected, were in the Caravelle's mechanical control system and in the area around the enlarged engine nacelles. French had said the fully powered control arrangement, which featured four individual hydraulic systems, had performed beautifully. Nor had there been any failures around the wind section, where the fuselage structure was altered to give the new 50% more volume.

Since jettison of shock and strut cylinders was the leading gear control problem, but none that affected reliable action of the gear. Because of the Caravelle's gross weight of 110,371 lb, the gear did not appear the static, buttressed models that need special test-runs on large jets.

"The gear went beautifully," French said. "We haven't had anything like the problems we experienced with our larger jets' landing gear."

United pilots have voiced general satisfaction with the Caravelle's landing characteristics, although some feel the Caravelles are slow in coming up to full power, showing apprehension on some low-visibility landings.

Preparation for the Caravelle was the most intensive overhauls by United for a specific aircraft. Teams were sent to Europe

to study the maintenance procedures of foreign Caravelle users. In this case, overhauls, cars were assigned to Caravelle maintenance was supplied with a pre-flight check reference device, designed by United, for converting metric units to English units. Some maintenance personnel were brought in from low costs because they could speak French.

"In negotiations with the Federal Aviation Agency, we took advantage of our current experience and gained a \$3,000,000 TBO on the airframe," French said. "This was a precedent in the U.S., where 2,500 hr is the usual starting point." TBO on the Avon engines started at 1,800 hr, but will go shortly to 1,600, French said.

#### Parts Stockpiling

In stockpiling more than 14,000 spare parts and materials, United made widespread use of comparison in determining adequacy of parts on, proper delivery timing, advance ordering requirements and lead time needed by suppliers. Douglas Aircraft was the initial stockpiler of Caravelle components, but the role has been assumed by People's Aerospace since Douglas cancelled out in Sud's U.S. operations.

"We actually are supplied ourselves on Caravelle parts," French said, "but we couldn't tie up elements with suppliers extending all the way to France."

And a practice of supplying subcontractors with spare parts from the Toulouse plant has resulted in United's





## WHY A SEMI-AUTOMATED CYLINDER OVERHAUL LINE?

Because we still haven't found a mechanical substitute for the skill and judgement required for a high quality overhaul. There are too many variables in components for, almost every cylinder requires a different treatment. Airwork installed enough cylinder overhaul automation to sharply reduce the cost per cylinder... but retained all the stations where human judgement preserves the quality of individual cylinder overhaul methods.

For example, Airwork replaces all valve guides at overhaul. The new valve guides are mated to exactly fit (within .001") their mating valve stems. The valves are measured, then put in a special board that shows exactly which one goes with the cylinder being mated. The operator mikes the valve stem, then selects the right size reamer from the

more than 200 stored in the cabinet in the background.

To maintain accuracy, the normal .006" taper in the valve stem has been reduced to not more than .002" on a special boring machine before it reaches this station. The combination of a less barrel shaped valve stem and a more accurately fitted valve guide provides maximum protection against oil leaks.

Airwork uses automation to reduce the physical effort involved in handling 25-pound cylinders... but keeps all the skills a quality overhaul demands. This is progress—without loss of craftsmanship—because more reason an Airwork overhauled engine will provide a long, trouble-free operating life.



ESSENTIAL  
AVIATION SERVICES

**Airwork**  
CORPORATION  
MILFORD, NEW JERSEY



rotching parts that are exact in every detail. This policy differs from that of some aircraft manufacturers, who merely give out specifications and let the subcontractors choose his own means of production.

"It's a real comfort to know the components you receive are ready to go right on the aircraft, and that they will fit," Peckham said. "This has saved us quite a bit of money."

### Supply Coordination

United also streamlines parts supply coordination in France but delivery proceeded so smoothly that he was satisfied in March.

Sad still has two technicians at the United base here, and Rolo-Rover has eight technicians.

United wanted to keep the nose team on Canaville overhaul to give maximum use of the group's learning curve. Thus it was decided to run the Canaville's through overhaul and after the take, rather than stagger them, in the DC-8s and 720s.

Drawing up the routing chart that would bring the Canavilles back to operation, United had to cut 700 in all the first aircraft allowable TBO so that the twelfth would come in when the aircraft had logged 1,000 hr. Thus, only 83.3% of the enhanced TBO time on the 700 Canavilles was used up before the overhaul cycle began. In comparison, United is able to use 91% of the time on its DC-8s through staggering their overhauls.

"But after that first overhaul, we'll schedule the Canavilles according to a pattern similar to that for the DC-8, and we won't have to rush them out here," Rolo-Rover said. "The next overhaul cycle for them should come about September, 1969."

Stacy at Canaville set scheduled west of Omaha, United used them as



## USAF, FAA Approve TF33-P-7

Pratt & Whitney Aircraft's TF33-P-7, 23,000 lb thrust turbofan engine which will power the Lockheed C-141 transport, has been approved by both USAF and the Federal Aviation Agency. The production engine already has been shipped to Lockheed-Garrett Co.

special section aircraft on the Chicago-San Francisco route to increase ferry capacity. About six of the 12 that have come in for overhaul have flown back with passengers aboard.

All in-service line maintenance and periodic checks on the aircraft are performed in Chicago.

First overhaul spent 21 work days at San Francisco, where 15,500 manhours were consumed in the normal overhaul. United allowed an especially long period for the first overhaul to get the 160-man work team adequate time for familiarization.

Subsequent overhauls are coming in on Tuesday mornings and averaging for 11 days of overhaul and eight working. Number of manhours has been reduced to 5,524,000. Overhaul costs per airplane, including engine, are averaging \$115,000.

"All delays we've encountered in overhaul have mostly come from organizations involved in post-overhaul flight tests," Rolo-Rover said. "We've been slightly late on about half the airplanes loaded on so far."

### 40 Modifications

About 40 separate modifications are being made during the overhaul program, ranging from minor items, such

as fasteners and fittings up to the strengthening of the bed assembly. Only noticeable change has been relocation of the rotating beacon, which was moved from atop the vertical fin to a point on the fuselage after the tail-fin vibration was analyzed.

United officials said the carrier has no plans to dispose of the Canaville, even though it is still considered an "interim airplane." Spokesmen said United needed the Canaville to establish quality while awaiting delivery of the Boeing 727.

However, United left Canaville depots on a 10-hour basis when it advanced depots on its DC-8 and Boeing 720s to 14 hours. Thus the Canaville's hourly depreciation is \$182 compared with hourly depreciation of \$185 on the 720.

## Soviet Hydrofoil Traffic

Moscow-Soviet Union, expects to carry more than 2 million passengers on hydrofoil vehicles this year, a 19% gain over 1962.

Hydrofoils are being operated on the Volga, Caspian, Ob, Irtysh and Amur rivers and other water ways in the USSR.





# WELL AHEAD

## WITH THE SHORT HAUL JET

The BAC One-Eleven is on final assembly. It has already been ordered by: BRITISH UNITED AIRWAYS, BRANIFF INTERNATIONAL AIRWAYS, MOHAWK AIRLINES, KUWAIT AIRWAYS and CENTRAL AFRICAN AIRWAYS. Passenger appeal and low break-even factors make the BAC One-Eleven the first choice for all short haul operators. The BAC One-Eleven is the jet successor to the Viscount with even better than Viscount economics.

THE BAC ONE-ELEVEN IS POWERED BY  
TWO ROLLS-ROYCE SPEY TURBOFAN ENGINES

BAC

# ONE-ELEVEN

**BRITISH AIRCRAFT CORPORATION**

ONE HUNDRED FILL MILL, LONDON SW1 ENGLAND  
USA: BRITISH AIRCRAFT CORPORATION USA INC.,  
295 JEFFERSON DRIVE HIGHWAY, ARLINGTON 5, VIRGINIA





## AIRLINE OBSERVER

► United Air Lines has decided not to convert its entire Douglas DC-8 fleet to Pratt & Whitney JT4D-1 turbofan engines, after discovering it was more practical to retain the PW JT4A-1 and -3 and JT4W JT4C-6 turbojets for the bulk of its DC-8s. United has found a better market where it can purchase surplus JT4As, which have a thrust rating only 1,200 lb. below the JT4D-1 turbofan's 13,000 lb. Time-between-overhaul (TBO) on the JT4A will reach 4,000 hr. by Apr. 25, whereas TBO on the JT4D-1 is 2,100 hr. United feels the lower purchase price and maintenance cost will more than make up for the JT4D-1's fuel economy. When United's three Douglas DC-8F freighters are delivered with the JT4D-1, the carrier's DC-8 fleet will consist of 11 aircraft with turbofans, 28 with JT4A turbojets and 10 with the JT4C-6 turbojet which, with 13,500 lb. thrust, is suitable on shorter DC-8 routes.

► Defense Dept. will continue to use private carriers for transport even after the current buildup of military airlift is completed, Defense Secretary Robert S. McNamara recently told the Senate Armed Services Committee. "Because we feel the need for maintaining a reserve in the private air carrier's capability," Lack of long-range airlift "is probably the most important shortage today, the one we are working to correct by the airlift procurement program," he said.

► Trans World Airlines is faced with the return of \$5,116,000 that a Civil Aeronautics Board consumer records board had been ordered to the airline for refunds between Feb. 5, 1948 and Dec. 31, 1951. The 16-year-old dispute between the Board and TWA began in April 1948, when the CAB held that TWA should have received only \$42,842,000 in refunds (not 90% of the \$50,085,000 it was granted). TWA has no reserve for the payment and may have to draw on general corporate funds if the repayment is required.

► Eastern Air Lines has begun a major effort to strengthen its passenger services, improve appearance of flight equipment and terminal facilities, streamline reservation procedures and improve flight operating efficiency. The campaign will cover 12 specific problem areas, each supervised by a top company official.

► Previews has been made in India's third five-year plan for the purchase of 30 medium-to-long turboprop transports—generally the Aero 745 being built by Ispahani in India—to replace Indian Airlines Corp.'s Douglas DC-3 fleet. Purchase of four Sud Caravelle turboprop transports is still under consideration.

► United Air Lines will enter its 50 Douglas DC-7 aircraft this year. Three of them will be taken by Douglas aircraft which United reserves the DC-8F freighters now on order. Carrier will continue operating the DC-6 fleet, including freight versions, which will supplement the jet freighters.

► Frontier Airlines is attempting to introduce a no reservation-type service under the title of "Go Show." The service, now being investigated by the CAB, would be provided between Denver, Phoenix and Tucson. Tickets would be \$30 to Phoenix and \$40 to Tucson, for a \$2.70 saving between Denver and Tucson. A seat would be guaranteed only when the passenger purchases a ticket at the airport at least two hours before flight departure. The airline estimates "Go Show" will earn an additional annual net profit of \$40,515, based upon carriage of 1,321 passengers.

► American Airlines has proposed granting reduced fares to United Nations delegates and residents of the U.N. Secretariat as a local shuttle basis similar to the reductions currently offered U.S. military personnel. National Airlines, in opposing the plan, stated that the more money would be used to offer the fare reduction to "foreign residents in Washington, D.C., the Organization of American States, American veterans organizations and/or the Daughters of the American Revolution."

## SHORTLINES

► Air Congo has joined the International Air Transport Assn. as an active member.

► Airport Operation Council told Congress that airport operations need to be able to operate from existing airports. The group said that airports need to be designed to fit the airport system, not vice versa.

► British International Airways has completed installation of Alcatraz's integral auxiliary jet turbine engines on its fleet of Lockheed Electra turboprop aircraft.

► Civil Aeronautics Board has granted Pan American World Airways temporary exemption authority to serve Beirut, Morocco, and Casablanca, Ghana.

► Continental Air Lines flew approximately 210 million aviation passenger miles during the first quarter of 1963, a 15% increase over the first three months of 1962.

► Japan Air Lines has introduced new four-day excursion fares on its domestic routes which will reduce fares as much as 25% on trips within Japan.

► Merila Co. saved \$2,866,714 in travel expenses during 1962 as a result of its policy requiring employees to fly nearest class on company business trips.

► National Airlines reported a 15% increase in the number of passengers carried in March and a 20% increase in revenue passenger miles compared with the same month last year.

► Pan American World Airways will provide 104 nonstop flights per week between San Juan, Puerto Rico, and New York—a monthly capacity of 70,000 seats. Schedule calls for a concentration of flights on weekends when traffic is heaviest.

► Pacific Southwest Airlines has decided to take three steps in its modernization program: installation of electronic reservations control center, build a \$500,000 facility for the removal of its turboprop engines and adopt a new ticketing system called Instant Ticket and a program of piloted California base.

► Scandinavian Airlines System has purchased six Caravelle Mark 3 transports to bring the carrier's Caravelle fleet total to 18, four of which are being used in Sweden under the terms of a cooperation agreement. Terms of the purchase include trade-in of six SAS Douglas DC-7 transports to SAS.



FASTER THAN YOU CAN READ THIS MESSAGE

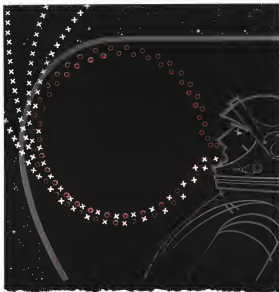
Collins Data Central can send it over all 256 of Delta's teletypewriter circuits!

Data Central is an automatic electronic switching exchange for teletypewriter and data networks. Delta Air Lines has a 256 circuit, 13,000-mile teletypewriter network that handles an average of 1,800,000 words a day. Delta has chosen Data Central for many reasons. Messages will be collected and distributed in milliseconds of a second. It's the economical way to maintain an information network. Keeps a 24-hour vigil over the Delta system with unparalleled accuracy. Provides historical records, accurate message accounting, message retrieval, and other allied benefits. As Delta's network grows and message traffic increases, Data Central will easily handle the additional load. And Data Central doesn't require a whole new order of procedures and equipment. It's compatible with other computers and communications systems. Could Data Central be your answer, too? Write for our brochure.

Communications and Data Systems Division  
COLLINS RADIO COMPANY  
Delta, Texas • Montreal • Toronto • Boston







**BREATHE  
EASY**

Hamilton Standard's experience in contaminant removal is being focused increasingly on new space life-support systems. Present work includes a contract to design and produce integrated space-suit assemblies for NASA's Project Apollo and extensive development of life-support systems and components for manned space capsules.

Hamilton Standard's life-support program applies diversified experience in hydraulics, pneumatics, mechanics, electronics, and packaging. Hamilton Standard blends and develops these basic technologies to achieve an integrated systems approach to life-support equipment.

**Hamilton  
Standard** DIVISION OF UNITED AIRCRAFT CORPORATION  
WHISKEY LEGS CONNECT YOU

**U  
A**

## SPACE TECHNOLOGY

### Mars Mission Study Proposals Evaluated

**Los Angeles**—Competing industry proposals for a study of system concepts for a manned Mars landing and return mission are being evaluated at NASA's Ames Research Center, Moffett Field, Calif. Two parallel, fixed price, nine-month contracts, not exceeding \$300,000 each, are contemplated.

The projected analyses are part of the program conducted for manned planetary exploration beyond the Apollo mission and anticipate three basic requirements:

- **Round trip**, single profile mission up to one year duration through each of oppositions from August, 1971 to July, 1976
- **Care of three to six astronauts**
- **Stay on Mars of three to 20 days**
- **Exploitation of Mars surface** for accumulation of scientific data in the immediate vicinity of the landing site, with possibility of excursions to other landing locations before return to earth
- **Chief aim of the study** will be a preliminary analysis to establish the technical feasibility and scope of the manned Mars mission. Relative evaluation of different system concepts will be performed and characteristics of the major planning procedures established to accomplish the goals will be stated
- **Technical problem areas** in which solutions will contribute significantly to probability of mission success, will be explored
- **These studies** must will include the following technical tasks:
  - **Exact trajectories** will be developed within limits of current knowledge of planetary motions and constants and computing techniques. This will include realistic analysis of effects of launch-lane variations, injection errors, midcourse corrections, planetary velocity variations, rendezvous systems at approach entry, landing and takeoff procedures, and plane changes for the return trip
  - **Trade-off studies** will be performed for the Mars orbital rendezvous mission made with or without an excursion vehicle in comparison with the direct mission mode. This will include analysis of orbital plane change and atmospheric requirements for the various shapes, payload weights, and velocity involved
  - **Feasible use of the atmosphere** and/or gravitational field of Venus will be studied to reduce total round trip time and energy requirements for the Mars mission
  - **Use of a lunar base** will be considered to determine if assembly and testing of payload systems, to be used for Mars mission rendezvous with the manned

board material used for environmental protection may be available for the earth return trip, NASA suggests

• **Task of maintaining the crew's attitude and physical condition** will be examined. Dignity requirements and communication, guidance and navigation tasks will be analyzed to give maximum degradation in human performance

• **Emergency return**, crew safety, failure hazards, and backup modes will be considered

• **Weight requirements** from earth or total weight will be computed for classical propulsion systems for the 1971 opposition, for chemical propulsion systems possibly only RIFT type gas phase oxy, nuclear upper stages for the 1973 opposition, and for chemical propulsion with liquid-fueled nuclear upper stages for the 1975 opposition

Concurrently with the manned Mars landing and return mission study, NASA is supporting a study of an unmanned spacecraft (Voyager) in performing orbiter-lander missions to Mars and Venus during 1967 through 1975 (AW Mar 12, p. 32)



**Centaur Shipped to Cape Canaveral**

Flight-equipped Centaur space vehicle, a third from the General Dynamics/Astronautics production line in San Diego prior to shipment to Cape Canaveral, being being lifted will be used for extensive ground tests with the Atlas launch vehicle. Next the Centaur for the Atlas currently is scheduled to fly, although both are flight-equipped. Next flight vehicle is 30 shown to be completed. Shown also are various large items shown while work is being performed on the vehicle.





SATURN SA-4 shows mating of Pad 34 at Cape Canaveral, Fla. Flight demonstrated vehicle's successful one-engine-out ability.

## SA-5 to Fly First Live S-4 Upper Stage

By George Alexander

Huntsville, Ala.—Marshall Space Flight Center, with four successful Saturn booster flights to its credit, is turning its attention to the flight this August of the first hydrogen-fueled upper stage.

S-4 second stage will be flown atop Saturn SA-5. There is a strong possibility that this flight might occur before the second Greater upper stage test is flown aboard an Atlas. Contractor also is scheduled for August.

S-4 stage, built by Douglas Aircraft Co. and powered by six Pratt & Whitney RL-10 engines rated at 15,000 lb thrust each, will carry a full propellant load of 100,000 lb. The stage will burn for 460 sec and inject itself, a guidance and navigation system module and a full liquid downer payload into an elliptical earth orbit ranging between 125 and 240 mi.

### Saturn Payload

Etanac weight in orbit will be 35,000 to 35,000 lb, the heaviest yet carried by the U.S. (AW Aug. 1, p. 32).

Payload also will carry one, or possibly several, tape recorders with voice messages. There is considerable agreement that one of the reasons will be that of President Kennedy, opening a window experiment done with former President Eisenhower's voice in Project Saturn in late 1958.

SA-5 booster will be the first of the

Block-2 Saturn S-1 stages to be flown. Block-2 vehicles (AW July 2, p. 117) feature the optional H-1 engine at 158,000 lb thrust compared with the 161,000 lb thrust H-1s on Block-1 vehicles, increased propellant capacity and stabilizing fins. The booster will carry a full propellant load of 350,000 lb and will be programmed to burn for 140.159 sec.

Flight also will be the first staged from Complex 17, the second Saturn launch complex built at Cape Canaveral to date by the National Aeronautics and Space Administration.

Preliminary data analysis of the fourth Saturn SA-1 flight (AW Apr. 1, p. 37) indicates that it was one of the most successful launches to date in the test program. Launched May 28 from Stand 34 at Cape Canaveral, SA-4 reached a peak altitude of 80 mi and a velocity at burnout of 7,662 mph,

and a distance of 212 mi down the Atlantic Missile Range.

Velocity was about 55 mph, higher than anticipated, giving added confidence to Marshall's growing belief that the propulsion system of eight H-1 engines is developing more than the calculated 13-million-lb thrust. Greater thrust is believed to average out to 1% over the course of the flight trajectory.

Flight (un-engineered) thrust would also explain shut-down of the four reduced engines at 112.9 sec, rather than the anticipated 114 sec. With all eight engines burning normally and supplied with 615,000 lb of propellant, run-off of the four engines would have occurred at T + 182 sec.

### Engine Shut Down

However, an engine was deliberately shut down at T = 100 sec, to test the S-1 stage's engine-out capability. Marshall engineers expected the burning time of the other seven engines to be extended an additional two seconds, or to T + 119 sec.

Orbital engines shut down after 120.5 sec of flight, when all liquid oxygen was depleted. That was the same shut-down sequence used on SA-3 (AW Nov. 26, p. 37). Orbital depletion probably will not be employed again

until SA-7, because of the importance attached to testing at the S-4 stage.

Possibility exists that this method of shutting down the S-1 might reduce oscillations in the S-4 during separation.

Engine-out experiment was described by one Marshall engineer as "remarkably successful." No S-4 engine, as intended, was shut down at T + 100 sec. It is a fact, and the propellants that normally would have been consumed by this engine (unavailable) in the other seven engines.

There were no indications of any disturbances in SA-4's trajectory caused by the sudden loss of one engine, nor were there any significant movements by the forward control system to compensate for its loss.

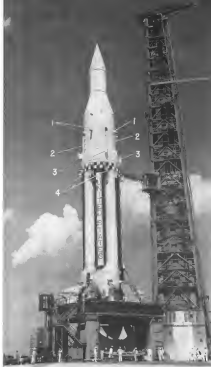
SA-4 also upheld the good intra-operation record established by the three previous Saturn flights (AW Dec. 5, p. 21). Otto Hoberg, chief of the Instrumentation Development Branch of Marshall's Astronautics Div., said that of 612 in-flight measurements carried by SA-4, only four were told lower. Eleven other measurements were not close, but are believed to be statistically acceptable through interpretation with other data.

Hoberg said that the Ames Corp. MR-100 airborne tape recorder also operated satisfactorily. The recorder was started at liftoff and ran until T + 153 sec, or about 30 sec after burnout of the S-1 stage. Only that part of the flight between T + 94.5 sec and T + 112.4 sec, covering the engine-out experiment through burnout of the retro-rockets, was played back. Playback was initiated at T + 164.4 sec.

Tape showed that radiation effects from the retro-rockets' exhaust lasted about 1 sec after the first burning of the solid-propellant rockets. Recorder performance was considered of equal importance to the playback of data.

All 16 telemetry links the General Electric Co. Maritime transponder and the RCA Astronautics Co. L-band altimeter also worked perfectly, according to Hoberg. The radar altimeter provided about 16 sec of data which can be compared for accuracy against that furnished by the Ames and Maritime systems.

Two omni-antennae accelerometers, which replaced the angle-of-attack sensors used on earlier Saturn flights, also operated satisfactorily. These are conventional spring-mass accelerometers; they will be used on operational Saturn I vehicles in pitch and yaw axis to detect loads much greater than 1g. There is no doubt that they will be used on the operational Saturn I vehicles in pitch and yaw axis to detect loads much greater than 1g. There is no doubt that they will be used on the operational Saturn I vehicles in pitch and yaw axis to detect loads much greater than 1g. There is no doubt that they will be used on the operational Saturn I vehicles in pitch and yaw axis to detect loads much greater than 1g.

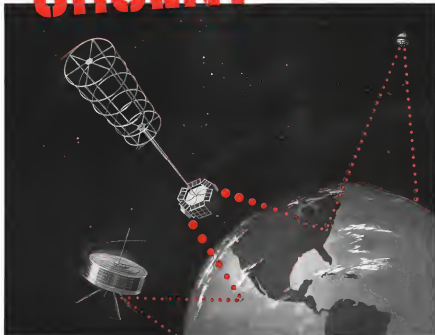


FOUSED AT COMPLEX 34, Saturn SA-4 is shown during final preparation for launch. Detailed in photo are (1) stage racks, (2) cable tangles, (3) S-4 retro-rockets, (4) S-1 retro-rockets. SA-4 was launched at 8:41 p.m. EST on May 28. Engine No. 3, one of four liquid-propellant motors shut down by a point timer about 100 sec of flight. SA-4 carried downer, water-filled S-4 and S-5 stages and a downer nose cone. Having achieved four successful Saturn booster flights, Marshall Space Flight Center is turning its attention to SA-5 which will contain the first hydrogen-fueled upper stage in the series.



# URGENT:

## CLOSE THE GAP IN KEY DEFENSE COMMUNICATIONS!



Today, with the security of the free world as heavily dependent on unbroken communications, the scientists and engineers of General Telephone & Electronics continually work to strengthen military communications. In so doing, they have developed a capability for providing a worldwide communications network that would be free of blind spots, blackout zones, or fading.

Such a network would involve satellite and ground communications interlinkages, and would require traffic control of such communications, tracking of satellites, data handling, switching, and a variety of display techniques.

GT&E brings a wealth of experience to all types of communications. For example, Letkvet Electric, one of the subsidiaries, is a world leader in multichannel telecommunications systems and in microwave communications at common-carrier frequencies. Sylvania has produced many secure and low vulnerability communications systems using ultra-reliable, solid-state techniques. GT&E Laboratories with Letkvet produced the radio suppression equipment that makes space communications practical.

Controlling communications traffic is an everyday function at the General Telephone operating companies. Providing near-instantaneous control for this traffic is a job performed by electronic switching systems of Automatic Electric. Space vehicle tracking, data handling and display systems, as well as the design and construction of the ADVENT antenna system, have been provided by Sylvania.

Supporting so vital a system with so many techniques simultaneously is one of the many ways the scientists and engineers of the General Telephone & Electronics corporate family bolster the nation's defenses. The vast communications and electronics capabilities of GT&E, directed through Sylvania Electronic Systems, can research, design, produce, install and service complete electronic systems. These systems include detection and tracking, electronic warfare, intelligence and reconnaissance, communications, data processing and display.

That is why we say the many worlds of defense electronics exist at Sylvania Electronic Systems, Division of Sylvania Electric Products Inc., 40 Sylvan Road, Waltham 54, Mass.

## GENERAL TELEPHONE & ELECTRONICS

Total Communications from a single source through

### SYLVANIA ELECTRONIC SYSTEMS

Including Automatic Electric • General Telephone & Electronics International • General Telephone & Electronics Laboratories • Letkvet Electric • Sylvania Electric Products





## If you had to understand what made it buzz... you'll be interested in a career at Aerospace

Your interest went past the dots and dashes. You had to know why the sound stopped when you let up on the key and why you could change the pitch by turning a knob. If this curiosity has expanded and sharpened with the years to include such areas as communication theory, coding theory, and telemetry, you'll probably find a great deal of satisfaction in a career at Aerospace Corporation.

Chartered to give the U.S. Government the benefit of the best in space and missile knowledge and experience, Aerospace serves as architect-engineer in the advancement of space science and technology. Aerospace does not engage in manufacturing. It is an organization dedicated to planning, evaluation, and technical direction of missile and space projects for the Air Force.

Aerospace Corporation's product is thoughtful guidance. If your creative imagination and high technical competence combine to produce guiding thought, you will find opportunity for satisfaction at Aerospace.

For complete information, write to Charles Ledwick, Room 106, P.O. Box 59061, Los Angeles 45, Calif. An equal-opportunity employer.

AEROSPACE CORPORATION



## NASA Favors Deployable Stations For First-Generation Space Study

Dalla, Tex.—Space station which will be capable of accommodating 174 men in an orbit 203,900 mi. from the earth for a duration of from 15 years, is in the current state-of-the-art and could be launched from Cape Canaveral in a Saturn 5 in the late 1960s, according to Marshall Spaceflight Center space station program manager Edward H. Olling.

Offering detailed research configuration under study by NASA, Langley Research Center, USAF and others, and stated that there had been sufficient study to indicate the feasibility of such a station as a space laboratory.

He indicated that earlier concepts, such as inflatable structures (NAS Aug. 22, p. 99), do not look too promising because of the problems associated with lifting the structure, crew support and laboratory equipment and packaging the inflated structure as well as the attendant complexity of inflating such a structure in space.

Three-spoke MSC configuration described by Olling would be fixed into the top of a Saturn 5 and be compatible with the launch vehicle. The main crew would ride in a command module atop the station which would consist of three swiveling spokes folded down. One spoke positioned in orbit. The station would be deployed by the crew. Equipment that would be checked out and the station would be ready to accept additional personnel. These might be ferried to the station in groups of six in modified "bus" configurations. Apollo command modules having two men at three about half-deaths' waiting.

Revolutions and personnel transfer would be via a central, located large capsule of housing four Apollo launch modules and could be designed so that the buses could be checked out inside the larger in a shuttlebus environment. Buses would be designed to be reusable for as many as a half-dozen years in space.

Timespace configurations would have a radius of approximately 75 ft. to be placed and react independently. Station capable of approximately 1 g. to provide varying degrees of artificially induced gravity along the length of the spokes. Spokes would be reinforced to provide separate laboratories, rest quarters and waste area. Centrally located lounge and recreation and control module could be designed to be used as a station while the spokes rotated.

Olling indicated that the personnel complement for the first six months might comprise six men, 12 men after

the ground and 18 men after a year in orbit—increasing personnel to over 90 during the full complement is about the station.

Space station of this nature would be capable of handling detailed long-term experiments in human, animal and plant life subjects in an environment of varying degrees of weightlessness. On human and animal subjects that would include clinical studies of metabolism, endocrine/immune effects, bone demineralization, muscle atrophy, sensory and canal phenomena, and cell nutrition. In the case of animals and plants experiments could be continued over periods of time permitting breeding and growth studies of these and other space-environment associated experiments, which would be extremely valuable in future long-duration planetary missions. Olling noted.

Station of this size also would be useful as a landing point for returning manned spacecraft where astronauts and their vehicles could be checked out and if necessary, quarantined, prior to their return to earth.

Olling considered that design and operation of such a facility, which would have an estimated \$9,000 to \$10 billion, would be a less stringent problem technically than Apollo, considering that it need not incorporate that program's complex navigation and guidance, lunar landing vehicle and to entry requirements.

He also considered that first generation space station be of the "in-service" type, rather than "in-laboratory" configuration requiring breeding problems associated in space, especially and assembling these in orbit, due to lack of experience and knowledge of lunar powerplants and components. Such space-assembled configurations probably would be utilized in second or third generation stations and where structure of considerable larger size would be considered necessary.

### Fibrillation Unit

Wenthouse—Unit designed to stop "ventricular fibrillation" in the condition that took astronaut David R. Scott out of the U.S. manned space flight program, has been added to its artificial product line. The Wenthouse Electric Corp. announced recently.

Wenthouse and the SIB, suit wear an electric shock to return the heart to a rhythmic beat. Ventricular fibrillation is a non-lethal quivering of the heart's muscle fibers.



## PROPULSION OPPORTUNITIES

Aerospace's Air-Bergerth has been looking for highly qualified propulsion engineers who can provide power and energy for the solid-rocket-propulsion system of the Air Force's proposed system of (MIRV) hypersonic missiles requiring high speed and precision of delivery. Opportunities, planning, and test systems.

Capabilities with high speed solid-rocket design and development experience. In addition to management experience in one or more of the following:

- Case and Structure Design
- Reaction Design and Materials
- Nozzle Design, Heat Transfer, and Gas Dynamics
- Thrust Vector Control Systems
- Power Servo and Hydraulic Systems
- Guidance Systems
- Propulsion, Grain Design, and Motor Testing
- Gas-Generator and Solid-Motor Design
- Test Operations, Instrumentation, and Data Reduction
- Vehicle Systems Integration

Qualified applicants are invited to contact Aerospace/Don Bernhardt, an equal-opportunity employer. Please write to Mr. E. H. Bernhardt, Room 101, P.O. Box 590, San Bernardino, Calif.



AEROSPACE  
CORPORATION



# Your requirements for flight-qualified VALVES

...call for these essential capabilities:

Thorough knowledge of missile and space systems ■ Experience with all cryogenic and storable propellants ■ The best in on-premise facilities ■ Highly qualified engineering talent ■ Demonstrated development achievements

RMD VALVES FLY IN AMERICA'S MAJOR MISSILE & SPACE SYSTEMS vent valves ■ relief valves ■ ball valves shut-off valves ■ venturi valves ■ hot valves disconnect valves ■ fill and drain valves flow limiting valves ■ squib valves ■ gas pressure regulators ■

**Thiokol**  
CHEMICAL CORPORATION  
REACTION MOTORS DIVISION  
DENVILLE, NEW JERSEY

## Apollo, Gemini Simulator Variety Planned

By Edwin J. Belton

Houston, Tex.—Gemini and Apollo training and simulation facilities planned by National Aeronautics and Space Administration will comprise approximately 24 types of devices ranging from computerized simple man-of-war to complex computer-driven equipment. Missions will provide astronauts with practice in entering and escaping from spacecraft, experience in working out real-time lunar rendezvous navigation problems and will assist in developing an inclination to crew vehicle safety. Some devices are already available, such as the high-speed jet fighters used for providing brief strong horizontal thrust. Others are in the proposal stage or are being evaluated from industry prior to announcing a contractor and some are still under development.

Gemini and Apollo flight trainers will be designed to represent astronauts with the following:

- Appearance and modes of operation of all instrument displays, switches and control systems.
- Detailed theoretical displays which can be reasonably anticipated and simulated.
- Detection and correction of in-flight anticipated errors before an error can be calculated.
- Dynamic response characteristics of the spacecraft as shown by flight test reports and orbital-theoretical displays for spacecraft motions covered in other simulations in visual control system.
- Overall motion timing and position of specific tasks contained in particular mission flight plans.

Flight trainers are considered the most important, and probably will be the most costly, of all the training rooms to be used in the Gemini and Apollo programs according to Howard L. Johnson, technical assistant to the chief of flight operations, NASA Marshall Spaceflight Center, Houston.

Crews can be kept down, he believes, in that actual physical translational and rotational spacecraft motions will be simulated. This occasion is based on concepts by Mission specialists first display motions close to final time problems are a surprisingly good approximation of combined translational and body motions under weightlessness in space. Launch and re-entry lunar accelerations can be reproduced satisfactorily as a jerked, or a outburst.

Flight trainers will have active instrument displays operating as an analog of actual spacecraft equipment. Hybrid analog and digital computers will simulate onboard systems and spacecraft response characteristics. Long-term navigation calculations, requiring low on-line computer data will be handled by the digital computer as well as most variables of onboard systems for which discrete values or limited response rates are required.

Analog computers will be used for short-term, high-response applications and for analog instrument readouts where itself even are not particularly important, or where the analog readout can be periodically converted either by the digital computer or by an extractor.

Out-of-the-window displays have not yet been fully decided, Johnson states. The Gemini trainers will probably have a fully automatic visual display of the celestial sphere and a display of earth points covered by clouds.

The Apollo trainers will probably have in addition, a display of earth and the moon from a wide range of distances and a detailed display of the moon from close-up views. The Lunar Evacuation Module (LEM) trainers will probably have a celestial presentation and a lunar dis-

KINNEY — EVERYTHING IN VACUUM



KINNEY 10000 CFM

**Kinney Mechanical Booster Pumping Systems**  
**Offer A WIDE RANGE OF DISPLACEMENTS**  
**FROM 30 TO 10,000 CFM**

These compact, space-saving units deliver new highs in volumetric efficiency at reduced dollar-per-cfm costs. Kinney mechanical booster pumping systems combine lobe-type rotary booster pumps ranging from 30 to 30,000 cfm with Kinney cam-and-piston pumps ranging from 5 to 850 cfm to attain ultimate pressures of  $2 \times 10^{-10}$  torr.

Bypass roughing lines on many models increase the efficiency of the roughing cycle and shorten the time required to reach booster cut-in pressure.

**KINNEY VACUUM DIVISION**  
THE NEW YORK AIR BRASS COMPANY  
325 WASHINGTON STREET • DOSTON 10, MASS





## He breathes easier now

One of the major Beckman subproblems man in space is to protect him from choking out from too little oxygen. Beckman meets this threat of hypoxia by testing his breathing air.

A tiny Beckman Sensor—the only one of its size accurate and reliable enough to monitor partial pressures of oxygen in closed atmospheres—travels inside the pilot's face mask or pressure helmet. Long before it detects any change in oxygen, the Sensor triggers a warning system that lights, alarms, or even speaks—telling him to take corrective action immediately.



The tiny Beckman Sensor shown here weighs a scant 2 grams, but withstands 50 g's as well as severe vibration. Working on an electrochemical process, response is rapid. In less than one second it detects change in the oxygen partial pressure. The electrolytic cell that does the work lasts up to three months. Easily calibrated in air, it can be replaced in seconds.

That is the kind of physiological monitoring hardware that has come to be expected from Beckman. For more than a quarter of a century Beckman has been testing, proving, delivering. With twenty-five per cent of its sales in the medical field Beckman is solving such problems for the U.S. space agencies and the military services, the RAF, and NASA. When it comes to your space-age medical problems, Beckman is one of the most qualified companies in the world. For complete information on Beckman Bioastronautics, write to Dept. M.

**Beckman**

INSTRUMENTS INC., Brea, Calif.

International Sales Office: Beckman Instruments, Munich, Germany, Garmisch, Federal

plus emerging from close orbits to enter planned landing sites.

One of the more difficult tasks now appears to be providing good control of window displays. Under study are new methods of producing these images electronically.

To each of the Gemini and Apollo flight trainers are expected to be provided, according to Johnson. One of them, for early generalist training will be located at the Manned Spacecraft Center, and the other, for specific flight training, will be located at Cape Canaveral.

Gemini post-test trainer is a modification of the MSC-based Mercury procedures trainer, the plan being to re-program the computer to represent Gemini procedures and act as a window view mid, based on a new cut-out-the-window display, which now develop into a complete display system applicable to both Gemini and Apollo flight trainers.

Apollo post-test trainer system will possibly include three static units: the earth launch and re-entry trainer, the navigation and trajectory control trainer and the orbital and rendezvous trainer. A study is now being made to determine whether units can be joined by combining these functions into two or even possibly one trainer.

### Trainer Work Load

Perhaps, trainers will be included with flight trainers, will permit earlier acquisition will use. They will eliminate most of flight trainer's work load. They can provide more accurate simulation as well as provide mission phases than the flight trainers, and free operational problems can be studied involving variables in simulation presented that cannot be handled in the flight trainers because of their design features or immutability.

Gemini and Apollo emergency programs will utilize the Navy Air Development Center equipment at Dayton which is a pattern developed in the Mercury program. A human centrifuge is also planned for MSC at Houston, which will be approximately the same as the Navy's work, but will have lower design maximum acceleration level of not more than 10g. MSC's centrifuge will also feature an increase in maximum period and the release of the gradient will be approximately three times greater, so that at least three men and necessary equipment can be tested simultaneously.

Apollon trainers will normally be backup mockups of the Gemini and Apollo spacecrafts having accurate reproductions of recovery equipment and escape paths. They will be accurately scaled in center-of-gravity and total weight to that their hydrodynamic be-

havior will study that of the actual spacecraft. Later in the program it may be possible that actual spacecraft that have flown can be used for this training. Johnson notes.

The Gemini post-test trainer, consisting of a backupplate spacecraft attached to a prototype payload, providing landing practice after release from a helicopter, is scheduled to be delivered to MSC from Edwards AFB, Pacific will be tested out at Ellington AFB, Houston.

### LEM Trainer

The LEM trainer, to be developed on the basis of research and development with Bell Aircraft's research vehicle (AW Feb. 15, p. 76) will include an accurately scaled mockup of the Gemini crew module with simulated landing and control systems and a jet engine that will produce lift equal to 1/10th of the LEM's weight to simulate a lunar gravity environment. The aircraft will achieve the trainer in free flight from the ground to various altitudes and practice attitude control, translational control and spot landings. Prior to this they will receive a program training in the large lunar landing facilities, exploring a tethered spacecraft suspended from an Airframe being provided by Langley Research Center.

The Gemini docking trainer is a large, ten-degree-of-freedom, racing boat simulator having a full-scale Gemini spacecraft mockup with four of the six degrees of freedom in 45-deg rotation in pitch, yaw, and roll and 24 in. in lateral translation. The Apollo vehicle will also be included accurately and have the increasing five degrees of freedom in 45-deg of vertical translation and 100-deg of range translation. Initially, this simulator will be utilized by McDonnell Douglas, contractor to Gemini, to solve actual hardware problems associated with docking and landing phases of the rendezvous mission and it will then be released for Gemini astronaut training.

Later it probably will be converted to an Apollo docking simulator, Johnson says.

### Gemini Trainers

Gemini trainers (trainer, built by Bendix Inc., Tulsa, Okla., are simulated breadboards of some of the actual spacecraft onboard systems, among flow path indicating techniques in their which components are activated when any particular input control is activated. These are designed to provide the astronauts with specific familiarization of spacecraft systems. Simulators will include checkout systems including sequences and procedures causing environmental service checkout and attitude attitude maneuver control system.

Apollon simulators will also include a

## need ALTITUDE SWITCHES BUILT TO YOUR SPECIFICATIONS?

CHANGES ARE WE CAN  
DELIVER TO YOU RIGHT NOW!

Before you order Altitude Switches built to your size, meeting specifications, check first. We will provide you the exact size, weight, and performance you need, ready for immediate delivery. This is because our specifications are yours.

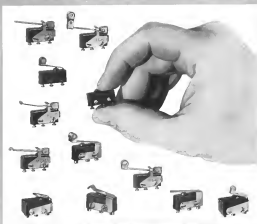
Not after the switch is sent complete, years later at Altitude Switches, ready for immediate delivery. Yes, we do deliver speed configurations.

**Spidel Corporation**  
A Division of  
**PRECISION CONTROLS GROUP**





## MICRO SWITCH Precision Switches



## PRECISION-MADE SUBMINIATURE SWITCHES hundreds of types and assemblies available

Where space and weight limitations are critical, MICRO SWITCH "SM" subminiature switches bring a combination of compact size, reliable precision operation and broad range of actuators, assemblies and variations to meet a wide variety of design requirements.

Long, reliable life. Wide temperature ranges:  $-100^{\circ}$  to  $+180^{\circ}$  F. SPDT contact arrangement. Catalog listings also include types with extra long life and extra high temperature char-

acteristics, gold contacts for low energy circuits, and bifurcated contacts—to name a few.

A field engineer from the nearest MICRO SWITCH Branch (See Yellow Pages) will be happy to show the complete line... or write for Catalog 63 now.



### MICRO SWITCH

MINNEAPOLIS, MINNESOTA

A DIVISION OF HONEYWELL  
IN CANADA: HONEYWELL CONTROLS LIMITED, TORONTO, ONTARIO

HONEYWELL INFORMATION SYSTEMS AND SERVICES OFFICES IN ALL MAJOR CITIES OF THE WORLD. MANUFACTURERS OF CONTROL SYSTEMS, SAFETY SYSTEMS, SIGNALING SYSTEMS, AIRCRAFT, MARINE, JET

three-dimensional linear trajectory surface—will be the only proper stage—which will show in our view except for spacecraft use, the relative dynamics of earth, the moon and the spacecraft system.

The earth model will be approximately 3-ft dia. requiring a building approximately 70-ft dia. to house the entire display. Each will rotate about its own axis. The earth-moon system will rotate about its total center of gravity which will be located at the center of the building. The lower axial plane will always be horizontal at all levels.

Calculated light from the proper direction will fall on earth to represent the sun as seen from earth, with an internal light slaving past a hemispherical movable shade to represent the sun's dimensions of the sun. A model, in the form of a cone whose apex would represent the position of the spacecraft, probably will be used.

#### Television Presentation

The spacecraft will have three degrees of translational freedom to permit the trajectories of actual Apollo missions to be traced. Motion of the spacecraft would be in response to man-pilot or taped commands. Taped commands could be speeded up to a factor of 1,000 to demonstrate a complete Apollo mission in approximately 20 min.

Because of the display's size, it could be viewed from an auditorium or outside position.

During actual Apollo missions, the display would be driven to keep pace with the mission permitting television presentations to be made to a world-wide audience.

The Apollo end-point navigation simulator still in the development stage by Ames Research Center, would connect an Apollo command module docking mounted on an air-bearing to a hemispherical domed moon of about 50-ft radius.

Scrubbed stars would be fixed as the dome's surface to provide the necessary high accuracy needed for practice of actual operations during the end-point navigation phase.

#### Future Facilities

Possible training facilities for future space flight projects include an extra-vehicular operations trainer on which NASA currently is doing studies. This concept would permit visualization of the problems facing an astronaut once free in vehicle. This would include simulation of partial gravity, falls, such as walking on the surface of the moon and moving in space from or toward a spacecraft and performing repairs, or assembly of components in space outside the vehicle. Such space activities

would enable the astronaut to practice space motion using simulated power or strapped-on propellant tanks.

As mentioned in one study, the lunar-lander coupler would consist of a structure including an axis of approximately 200 ft x 100 ft x 200 ft, although smaller axes are also being considered. A dynamic support cradle will provide an unstable driven element. The wheels would operate against the inside surface of a hemisphere so that the dynamic cradle can have enhanced angular motion about any axis without encountering ground loads.

The cradle would be damped to provide a slow sway space so that it could

would enable the astronaut to practice space motion using simulated power or strapped-on propellant tanks. As mentioned in one study, the lunar-lander coupler would consist of a structure including an axis of approximately 200 ft x 100 ft x 200 ft, although smaller axes are also being considered. A dynamic support cradle will provide an unstable driven element. The wheels would operate against the inside surface of a hemisphere so that the dynamic cradle can have enhanced angular motion about any axis without encountering ground loads. The cradle would be damped to provide a slow sway space so that it could



**SUCCESSFUL  
TV-IN-SPACE  
CAMERA "OFF-  
THE-SHELF"  
TO YOU ...**

Proven as a mediate-focus camera, picture of the Echo-bulb system, successfully simulating the liquid hydrogen effect inside Centaur fuel tanks, now ready as a flexible-focus camera, adaptable to your approved viewing mode. The four Super Model-I camera offers a broad range of capabilities to meet your "TV-in-space" requirements. Camera unit is 2 1/2" dia x 6". Control unit is 9" x 6 1/2" x 3 1/2". Total weight is 7.5 lbs. Send us your optical requirements for low light level, anti-back, remote guidance, enable focus, or ground video system. Electronic Instrumentation Division of Lear Siegler, Inc., 371 H. Roadhouse St., Anaheim, California.

transmitting a continuous, clear proven as a slow-focus camera, successfully simulating the liquid hydrogen effect inside Centaur fuel tanks, now ready as a flexible-focus camera, adaptable to your approved viewing mode. The four Super Model-I camera offers a broad range of capabilities to meet your "TV-in-space" requirements. Camera unit is 2 1/2" dia x 6". Control unit is 9" x 6 1/2" x 3 1/2". Total weight is 7.5 lbs. Send us your optical requirements for low light level, anti-back, remote guidance, enable focus, or ground video system. Electronic Instrumentation Division of Lear Siegler, Inc., 371 H. Roadhouse St., Anaheim, California.

LEAR SIEGLER, INC.



ELECTRONIC  
INSTRUMENTATION DIVISION  
Lear Siegler, Inc., Anaheim, California



# APPLES & ORANGES?

No! Although these two instruments are dissimilar in appearance and different in function, they are completely compatible products with these two things in common:

- 1 They are highly refined instruments for measurement, and
  - 2 They are typical products of Singer Metrics.
- Precise measurement is our field of interest and activity... and providing the kind of instrumentation necessary for the progress of science, engineering, and production is our prime goal. For the state of the art we only advance as far and as fast as standards and techniques allow.

■ These two products exemplify this progress. The Turk High Voltage Divider (left), typical of **Breaker Research**® laboratory and production standards instruments, provides a means for measurement—0 to 750 kv—high-voltage energy. Paralleling 500 high order of capability, the **Paramic**® Microwave Spectrum Analyzer (right), offers unexcelled sensitivity throughout its entire frequency range with exceptional frequency and measurement versatility. These are but two examples from an extensive list of more than 150 electronic and related measuring instruments bearing the Singer Metrics imprimatur.

■ Both **SENSITIVE RESEARCH** (electrical measurements) and **TRIGORANCE** (electronic measurements) are part of the Singer Metrics combine. Both are expanding their product lines, and production is

the highest in history. Other research and production activity includes precision electro-mechanical assemblies and devices, electro-mechanical testing, and military electronic systems and subsystems.

*The nature of progress:*

**SINGER METRICS**

**SINGER METRICS DIVISION**

THE SINGER MANUFACTURING COMPANY

910 PINEBROOK STREET—BRIDGEPORT 8, CONNECTICUT 06601

14 Instruments of 700-800000 ELECTRONIC EQUIPMENT COMPANY



ELECTRICAL MEASUREMENTS—DC TO 1500 MC



ELECTRONIC MEASUREMENTS—SUBSONIC THROUGH MICROWAVE

RESEARCH AND PRODUCTION: Electronic and electrical measurement, calibration, and analysis instruments—precision electro-mechanical devices—environmental testing and evaluation—military systems and subsystems







## Tubes designed from the user's viewpoint ...use them wherever reliability is essential

When reliability really counts—as it does in active communications—be sure with tubes custom designed and tested for the job. Sylvania engineers designed the 6B Gold Brand tube with engineers and maintenance groups in broadcasting, public service radio, telemetry, the airlines... Subject to these problems and studied them. From this extra care Sylvania built a superior line of tube and support tubes.

Each tube made to a specific job. A given tube may have, for example, low noise, excellent stability, or vibration resistance. Or a critical parameter may be as much as tube length, the grid value. In each case, performance and reliability have been verified by actual use in service as well as laboratory testing.

To a tube effort has paid off. "Excellent results," says an airline official. "No failures."

reports a highway patrol department. "Hundreds of dollars saved in repairs on intercom buses," reports a TV station. "Less costly in the long run." discovered a county government. Similar results can be yours with a tube that's proven itself. Sylvania 6B Gold Brand Tube.

Electronic Tubes Division, Sylvania Electric Products Inc., 1000 Main St., Buffalo, N. Y. 14201.

AVAILABLE FROM YOUR SYLVANIA INDUSTRIAL TUBE DISTRIBUTOR

# SYLVANIA

GENERAL TELEPHONE & ELECTRONICS



## MANAGEMENT

# Prospects Slim for Mach 3 Interceptor

By Philip J. Khan

East AFB, Colo.—Air Defense Command's hopes for Defense Dept. approval of a new Mach 3 improved manned interceptor (IMI) received scant support from Defense Secretary Robert McNamara in recent testimony before the House Defense Appropriations Subcommittee. McNamara called the program "questionable."

While McNamara's testimony revealed Defense Dept.'s intention to develop the capability to destroy bombardment satellites in case the Soviet Union should adopt such weapons, indications are that Army's Nike Zeus missile will lose the bid to the capability rather than Air Force's proposed second-generation interceptors.

The Pentagon also takes a dim view of Air Force proposals for ICBM defense systems that would use large numbers of satellites for intercepting enemy ballistic missiles. Agreement that are used against the saturation of satellites are extremely high cost, vulnerability to enemy countermeasures and the unsuitability of complex spacecraft.

### Nike X Emphasis

Instead, Defense Dept. is putting its ICBM defense emphasis on the new Nike X, for which the Army is the responsible agency.

"There are mixed opinions here on the seriousness of the threat of hostile

Soviet military action from space, but the most sharp criticism of USAF's Sentinel Interceptor (Sentinel) program will neither blow is ADC's latest role.

Add to that the current study of how to enhance ADC, ordered by Defense Dept., which is expected to run the present force by at least 1975, and it is easy to understand why there is an atmosphere of uncertainty and frustration evident at ADC headquarters.

The command's current inventory of about 900 Convair F-106 and McDonnell F-4H interceptors would be no match for repetitive launches,

and even the capability is being cut by roughly 25% per year by accidents and other attrition.

Both ADC and the North American Air Defense Command (NORAD)—the U. S. Canadian joint service command located here—have so far mounted the temptation to bolster their current capability with an intercepter version of the new McDonnell F-4C or the Navy's F-4B (Jannet F-4B) in the hope that a Mach 3 interceptor would be developed instead.

### High Merits

In two actions of ADC headquarters, reports of extremely high-burn rate, early warning and rapid interception (AW Feb. 18, p. 89). Yet, while early warning was only a means toward the end of destroying an incoming target, today it is in itself in itself in the field of atmospheric ballistic missiles and satellites, since Air Defense Command has no way to destroy these targets now.

This is less than satisfying to former fighter-interceptor pilots who are long accustomed to being able to engage an intruder in combat.

There is general agreement among ADC and NORAD officials that their two



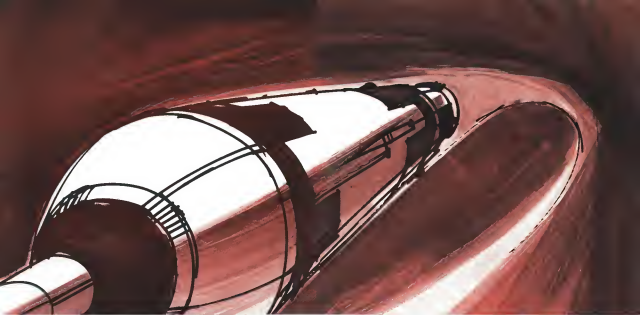
### First Photo Shows Hunting H.126 in Maiden Flight

First photo of Hawker Siddeley Harrier aircraft in its second maiden flight (NW Apr. 2, p. 37) shows the aircraft in usual low formation during forward flight after island take-off. Royal Aircraft Establishment field at Bedford, England. H.126 was built by Hawker Aircraft under Ministry of Aviation specifications to investigate flight potential of jet flap. Engine often fires trailing edge as seen in this short screen full wing open is used to produce lift and thrust. Forward-looking single thrust Siddeley Olympus engine, with side thrust thrust obtained from nozzles housed in lifting behind main landing gear (AW Sept. 3, p. 24).









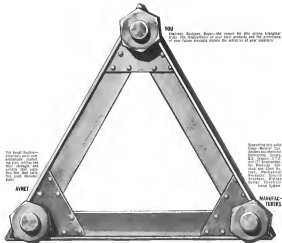
### Thrust vector controls...from the people at Bendix

Techniques of steering rocket engines are a specialty of Bendix people. We pioneered movable exhaust nozzles. We are in production on secondary injection systems. We are developing solid probe thrust vector controls. □ Other people at Bendix are working on rocket equipment, high temperature composite materials, nuclear mechanisms, propulsion controls and landing gear for both aircraft and space vehicles. An Aerospace team of skilled and experienced people...skilled in all phases of program management, backed up by complete engineering and production facilities...gives Bendix the capabilities to undertake many varied Aerospace programs. □ To find out what this Bendix team can do for you, write: General Sales Manager, South Bend 20, Indiana.

**Bendix Products Aerospace Division**







The Knight-Ridder-American's new corporate structure started its plans, which include strengthening and solidifying their position in the local news business, with a merger between the two companies.

Supporting this call is Greg—Norely? Co. owners and internal community leaders. G.I. Jones, DTC and IT Association, for example, has met with Greg Jones, who says, "We're not just a company, we're a community." Jones, who says, "We're not just a company, we're a community."

# STRONG SOLID

**SOLID**



<https://doi.org/10.1016/j.sbsbs.2023.100001>  
<https://www.sciencedirect.com/journal/Sustainable Business Strategy>

[illegible]

however delivered. How this is done is not as important as getting the conviction that it must be done. Once we are convinced of that, then American ingenuity can attack the problem. In my view, an ICRM database would justify another Manhattan Project, when we talk about halting nuclear disasters we must include all means of delivery—aircraft, missile, satellite and submarine. — Gen Lee and

### U.S. Vulnerability

"We have never previously been in a situation where the land and people who constitute our base base of operations have been vulnerable to immediate, devastating attack. If this base is destroyed then subsequent politics, action loses meaning, for our people collectively represent the political and social institutions which we seek to defend," Gino Luc concluded.

Defense Secretary McNamara appears to have most of these views, as evidenced by his statement to the House Armed Services Committee that ICRM defense is "the most urgent problem confronting us in the Conventional Air and Missile Defense Force. I believe that the matter of air-to-air defense is so important that we must make every effort to develop an efficient system... accordingly over \$450 million is allocated in the 1964 budget to initiate Nike-X development and now issue the Nike Zeus test program and extend our anti-missile Project Defender," McNamara said.

But AICC officials would like to see more emphasis on anti-air ICHM defense systems. They are inclined to the view that a defense using satellites is worth exploring in greater depth than is now authorized by the Defense Dept. One of the more promising systems of this type is known by the acronym of *Sats* (satellite orbital track and intercept), proposed by General Electric's Missile and Space Div. (AW Feb. 4, p. 34).

Understudy, which required a large number of satellites orbiting over the Soviet Union where they would be vulnerable to interceptors. Such proposals to place satellites in an inclined orbit would add at least 200 km in altitude, where they would trace out a figure-eight orbit over the Atlantic and Pacific oceans. Where Hanks proposed to use a satellite both for target detection and launch of antisatellite missiles, Such proposed to use separate satellites for the two functions, with the killer satellites controlled from the ground.

### Technical Problems

There is an understandable impatience here with the technical difficulties involved in such a defense, and with those who request a go-slow legislative study first, because these are military men who never before have encountered a threat so far beyond their available resources.

Norad and ADC officials believe the nation must face the threat of sus-



### F-104s Readied for Japanese Air Defense

Ledhead F-104D) two-seat tailers, like No. 785 in center foreground, and F-104 single-seat interceptors are shown as large at Vothahelo Heavy Industries' Kamda plant near Ngeya. Total of 280 around-195 F-104s and 30 F-104Ds—now programmed for use by Isuzu as delivery here.

for accurate measurement of  
tension and compression loads

**HUNTER  
FORCE GAGES**

■ **Hunter Mechanical Force Gages** are rugged, compact direct-reading instruments for measuring tensile and compression loads. They can be used to establish maximum/minimum performance standards, or on production lines to test conformance to these standards. Gages have a "hold-at-maximum" indicator which holds the highest force attained until released.



are available in 7 models to measure force ranges from 2500 lbf up to 5000 lbf. They are useful in measuring the HITCHED Series built into bearings 401448. CUMMINS systems to eliminate air leak on porous surfaces. They are used in test the artificial "heat" of the rubber profile.

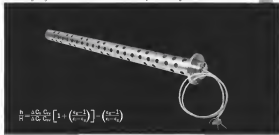


Complete details and prices are given  
Bulletin 704 (FD). Write for yours now.





How many ways can **TRANS-SONICS, INC.** serve you?



$$H = \frac{\Delta C}{\Delta C_{\text{ref}}} \frac{C_{\text{ref}}}{C_{\text{ref}}} \left[ 1 + \left( \frac{\Delta C}{C_{\text{ref}}} \right) \right] - \left( \frac{\Delta C}{C_{\text{ref}}} \right)$$

## LIQUID LEVEL

is measured in many ways. The sensor does it by variable capacitance and linear part of a capacitor. Trans-Sonics' option. With its solid state black box, the meter provides a depth of output accurate to 0.1 inch in 4 feet.

Automatically corrected for density changes, the Trans-Sonics tank gauging system is suited for application as well as conventional fluids. Indications of wet up and overpressure variations, and with a response time of four milliseconds it is also used to measure L/CX and L/C-VI wave rates as an airborne environment. The system provides accurate data relating to pipeline extension, lower sensor displacement, and well subsequent the performance of critical mechanical assemblies.

Variable capacitance is only one of several techniques used by Trans-Sonics for the measurement of level. Differential pressure, pressure effects and thermal induction are also used for systems having either analog or digital outputs. From liquid hydrocarbons to low viscosities, Trans-Sonics devices are providing accurate and reliable readings in the most demanding situations — may we tell you more? Write, fax, or phone — 1-800-333-3333.

*To put the eye in measurement...*  
**TRANS-SONICS, INC.**  
1000 N. 10th Street  
LEXINGTON, MA 01846-1000



## Army Troops Test Loading, Egress, Seating of CH-47A

Troops at Army's Ft. Rucker, Ala., are shown during war transformation checks of the Boeing Vertol CH-47A Chinook assault helicopter. Seven Chinook production models were delivered to Ft. Rucker, thus an ongoing war testing and low air in pilot training. First operational Chinook was recently delivered to Ft. Rucker, and is scheduled for delivery this spring to the 103rd Helicopter Squadron at that installation. This is the No. 10 aircraft in the area.

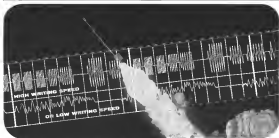
since Soviet battles at least until 1973 — perhaps even longer if they are used as a second strike force. If this appraisal is correct, the present inventory of interceptors will have dwindled to imprecision in numbers and capability by later in this decade.

Stand and ADC's, therefore, have submitted requirements for the improved manned interceptors, or IMI. The interceptors would have a speed of slightly better than Mach 3, a endurance of perhaps three hours, and would be

equipped with a high-power airborne radar intended to make it less dependent on ground radar to locate its target.

Officials here acknowledge that in a surprise attack, the enemy's first blow is most likely to be struck with ICBMs and submarine-launched missiles, with some Standby covering in for the cleanup operations. They concede that under such conditions, much of the present SAGE air defense system would be destroyed, forcing an IMI to operate largely on its own.

McNamara told the House Armed Services Committee that the Pentagon intends "to make a thorough study of the entire problem of modernizing our manned interceptor force and we hope that next year we will be in a better position to make some definite recommendations on this subject." To expedite this study, USAF Maj. Gen. A. C. Agos, ADC's deputy chief of staff for plans, is an temporary assignment to the Pentagon. McNamara noted that if Russia deployed a new Jag-



## The one oscillograph paper for widest range of trace velocities—Anso Linatrace A-4

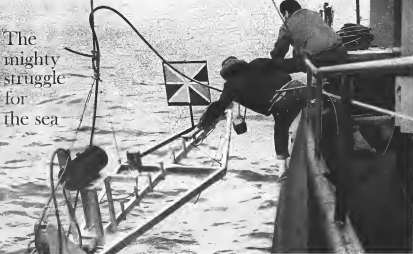
The universal photo-recording paper has the high speed required to record clearly high frequencies at high trace velocities... plus the latitude that makes it well-suited to relatively low writing speed applications. Ask your Anso industrial representative for complete details on Linatrace A-4.

Anso's <http://www.anso.com> is a photograph of photograph. 1988 1988

**Anso**  
A Division of  
ANSCO INDUSTRIAL CORP.  
Department A-4



# The mighty struggle for the sea



One goal of Hughes' new ship is underwater listening—ship or the effects of sea surface conditions on sound waves. TV set behind TV is hand

How far can TV "see" underwater? How fast should it be? Are there unexplored sea techniques which could be useful in the battle environment? There are questions which are being answered by Hughes engineers and scientists aboard reconnaissance ships and at land facilities. Back aboard is a vital link in a massive struggle—to know the sea to control it. And while we know a great deal about the atmosphere and space beyond—we know less about the sea even though it holds such greater potential resources.

One of Hughes' most important activities is at sea—Jewell Reconnaissance and Ringing—presently the most effective tool in active defense and exploration.

For example, in submarine has become more capable—diving deeper, moving faster and faster—we are not obliged to develop more effective means of detection, classification and location. Working with the U. S. Navy, Hughes scientists and engineers are engaged in all aspects of research, development, production and distribution of our systems. They are being developed

for surface vessels, submarines, aircraft and for the ocean's floor. Some specific programs include submarine

reduction measurements, analytical and acoustical testing, identification and test data, ship studies, and the development of

The 100-foot *Timex* X submarine vessel is one of the most advanced ships used in the Navy. It is a 1000-ton vessel.

**RECON** is the most important activity in the sea. It is the most important activity in the sea. It is the most important activity in the sea.

Hughes Aircraft Company

CREATING A NEW WORLD WITH ELECTRONICS

**HUGHES**

HUGHES AIRCRAFT COMPANY



## Trident Cockpit Undergoes Bird Impact Tests

Flight tests of the new *Trident* cockpit design are under way after 13 bird impact tests conducted at Naval Air Station, Naval Air Station, Naval Air Station. The tests were conducted at Naval Air Station, Naval Air Station, Naval Air Station. The tests were conducted at Naval Air Station, Naval Air Station, Naval Air Station.

range, however, "we would have to consider the size and character of the intercepter force and particularly the need for maneuverability."

Navy and ADC officials decline to disclose their estimates of the cost and time schedule for the IMI. But Pentagon officials told *American Week* & *Space Technology* that ADC estimates a Mach 3 interceptor could be devel-

oped and placed in service within four years on a cost-plus basis, at a cost of approximately \$2 to \$5 billion. Some Pentagon officials believe these figures are somewhat on the optimistic, however.

While the IMI could become airborne upon first warning of an enemy ICBM attack, they would soon run out of fuel unless energy sources quickly followed the missile attack. ADC believes that it can count on using dispersed air fields to ensure that some survive the initial attack to serve as refueling points. However, that assumption is expected to meet considerable scrutiny in the Pentagon study, particularly since a Mach 3 interceptor may not be able to operate out of more existing air fields.

Pentagon officials point out that there are several alternatives to the IMI which may appear more attractive under Defense Dept. cost-effectiveness studies. One of these would be to develop an improved long-range, multi-aircraft intercepter for use with a Mach 3-plus IMI or the F-4C.

Another possibility is use of the F-111 (FEX), which is intended to be suitable both for tactical and air defense missions.

## F-4B Interceptor

But AFM, Colo.—While Air Defense Command has so far resisted efforts to convert it to the McDonnell F-4B-40 intercepter because it prefers *Phantom* II for development of its new Mach 3 intercepter, the F-4B is expected to have some highly with the *Phantom* II. The F-4B is expected to have some highly with the *Phantom* II. The F-4B is expected to have some highly with the *Phantom* II.

As *Shaw* was writing on the way to talk off a Navy F-4B, he was charged to intercept a USAF Strategic Air Command B-52. *Shaw* was making a simulated attack on the bomber.

interceptors, acoustic wave systems, high gain receivers, sonobuoys systems, helicopter sensor and advanced data processing and display systems.

Other Hughes programs, activities in cooperation with major oil companies and other groups, include the nonstop-controlled *SONAR* system and new varieties of dynamic ship positioning devices. *SONAR* is today working the ocean's depths—discovering oil fields and other resources in their territories.

These activities and others, show their contribution to a Hughes belief that the only way to understand the sea is to work with it. That new ideas and new equipment can prove their worth only when subjected realistically in the rigors of the ocean environment. Engineers and scientists with abilities and interest related to these or other Hughes programs in advanced electronics and space are invited to inquire. Hughes is an equal opportunity employer. Please address Mr. S. K. Gillette, Manager Employment and Manpower, Hughes Aircraft Company, Culver City 31, California.





## WE USE BOTH ENDS OF THE PENCIL...

*to solve advanced systems research problems*

Out beyond the State-of-the-Art, original solutions to the formidable new problems of today's advanced electronic systems depend on the effective application of three as important tools... the pencil, the eraser and man's brain. At Motorola, these factors have been successfully applied to the design and development of such major electronic systems as the NAVAIR/Griffon/Huag-8/Huag-10 to the Satellite Tracking System... the Air Force data acquisition and analyzing system at the Edwards AFB high speed flight corridor... and the HADAS random access, discrete address system.

If you are interested in participating in these stimulating areas of systems research, write today describing your background and training as:

**Applied Systems Research:** conceptual design and equipment development, communications theory, coding theory, logic systems design, systems and analysis, and operations research as applied to both military and non-military systems.

**Systems and Sub-Systems Design:** internal and microwave design, integrated circuit publications, system analysis and test methods, digital and analog communications, command and control, telemetry and tracking systems design, data processing and display, vulnerability design techniques, radar and guidance equipment.

We are particularly interested in programs on which this experience was obtained, and the extent of your technical responsibility. Address information to our Manager of Engineering at the location of your choice for immediate attention.

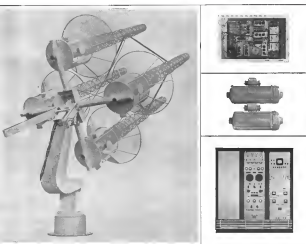
**MOTOROLA**  
*An equal opportunity employer*



**Military Electronics Division**

CHICAGO 27, 10300 MIDWAY, 60666 / QUINN AVE., SCOTTSDALE, Arizona 85224 / McJannet Bldg., REVEREND, CHICAGO, 60620 / MILWAUKEE AVE.





## Complete automatic telemetry tracking systems...priced from \$25,000 to \$250,000

Cubic telemetry tracking systems cover the complete spectrum of frequencies, performance...and price. For example, the Cubic ACAVE system shown in the illustration is complete and ready to perform automatic aerospace tracking. It includes the antenna system mounted on a pedestal, a three-bay electronic cabinet, plus servo and tracking receiver systems. This particular system sells for \$70,000. Other Cubic telemetry and tracking systems sell for as little as \$25,000 or as much as \$250,000, depending on the features desired. Cubic ACAVE's have performed flawlessly as the primary acquisition equipment for Project Mercury, as well as in a variety of other applications.

Cubic is able to offer this wide range of telemetry tracking systems at very competitive prices since Cubic has performed the major research and development, and delivered such a large volume of systems. Because of the wide spectrum of equipment available, Cubic engineers can meet the requirements of range operators and eliminate costly development time. For further information on Cubic ACAVE tracking systems, write for Technical Memorandum 102, Dept. B-136.



OTHER OFFICES: WASHINGTON, D.C. • COCOA BEACH, FLORIDA • LOS ANGELES, CALIFORNIA • BOSTON, MASSACHUSETTS

## AERONAUTICAL ENGINEERING



ALL-METAL MOCKUP OF SIKORSKY CH-53A. Sikorsky Corp.'s heavy assault helicopter shows fuselage configuration and engine placement.

## Sikorsky CH-53A Passes Mockup Review

By Donald E. Fink

**Stratford, Conn.**—All-metal mockup of Sikorsky Assault CH-53A. Marine Corps heavy assault helicopter passed its preliminary review recently, with few changes recommended by the Navy Sea-Wings review team.

Production of two flying prototypes has entered the metal-cutting stage and first flight is scheduled for June, 1964. The four-ton capacity helicopter, which

will be powered by two General Electric T64-GE-6 turbohaft engines rated at maximum power of 2,510 hp, each, is scheduled for fleet delivery in 1966.

The two prototypes, a static test airplane and the mockup were ordered in a \$8,737,502 Navy research and development contract awarded to Sikorsky last fall (ENR Sept. 3, p. 24).

Production contract currently is being negotiated with the Navy, but Sikorsky already is tooling and purchasing ma-

terials in preparation for continuous production. The first two production helicopters will follow the prototypes down the assembly line. Announcement of the use of the production contract is not expected until late in August.

Mockup construction was chosen for the mockup because it permitted faster and cheaper construction and also enabled Sikorsky engineers to achieve manufacturing techniques which will be used to improve the CH-53A's produc-



REAR VIEW SHOWS CABIN COMPARTMENT layout (left) with cushioned cargo door-ramp open. Ramp supports 3,000 lb. load safely. Escape hatch is shown (right) as upper door panel. Toilet blades will be stored on top of baggage in production aircraft.

AVIATION WEEK & SPACE TECHNOLOGY, April 13, 1963



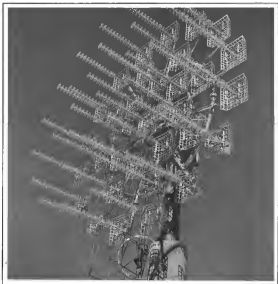
## DIVERSIFIED ELECTRO-HYDRAULICS

**SERVO RESPONSIBILITY FOR THE BIG ONES** Little ones, too. Size is no deterrent to the proven efficiency of servo controls by Brake Shoe's Aerospace Division. ■ Here's experience and time-tested products for the sophisticated servo systems of today's aerospace industry—products like the *Ashley Air Free* servo valve, now redesigned, which can give pressures as large as 150 sections without loss of function, and the new solid-state air (Electronic Servo Package) whose computerized design allows infinite customizations for specific applications within the control console. ■ Special servo control systems and interconnections govern such sensitive electro-hydraulic devices as hydraulic power supplies and meters, actuators, and pumps—all compatible products of the Division. Commercial industry is attracted through instruments like the compact *Ashley peak pressure gauge*, especially created to help technicians keep hydraulic systems at optimum efficiency. ■ Whatever your servo system needs, maintenance for up-and-quickstart operation, or systems to control the largest ground equipment—

—Brake Aerospace Division, Electronics

Dept., 3150 W. 5th Street, Channahon, Calif.

**AEROSPACE DIVISION/AMERICAN BRAKE SHOE COMPANY**



**CH-53A COCKPIT PANEL** is split with pilot's engine and flight instrument group at right and copilot's navigation instrument and communication control group at left. Console between seats contains tactical display plotting board (upper left) and sidestick. Note engine power trim console atop the sidestick stick.

brake, according to Charles M. Echeverria, CH-53A program manager.

Echeverria and a single "brake-toy" principle was followed in developing due to stamp out aluminum parts which could be used interchangeably on either side of the machine's semi-monocoque fuselage. Fuselage boxes were formed by welding stamped ribs together. Frames were then joined with aluminum and steel panels were riveted onto them. Floor is all conventional box construction.

Stamped parts also will be used in production machine, but aluminum forgings probably will be used in the main fuselage structural members in place of the welded frames, Echeverria said. Skin on the forward one third of the fuselage and leading edge of the tail plane will be built into the tapered streamlining.

The CH-53A, designated S-65 by Sikorsky, is the third stage of the company's large helicopter development program and draws on advanced computer technology developed for the main rotor, cyclic S-65—military designation CH-53—and the S-64 Thing Crane (AWM-14, p. 17). The design team also draws from engineering experience gained in the S-65 program, but the CH-53A essentially is a new aircraft.

The S-64, which is powered by two 4058-shp Pratt & Whitney JT12A gas turbines, has its engines mounted together on top of the fuselage and ahead of the main rotor transmission. The engines drive rear-mounted gear boxes which are coupled with the main transmission.

The CH-53A's two T64 GE-6 engines, which have front drive gear boxes are mounted in stream-lined nacelles which protrude at 45 deg angles from the upper corners on each side of the forward fuselage section. The engines gear boxes (located in the front of the nacelles) are driven by output shafts extending from the forward end of each engine. Power is transmitted to the other shaft via input shafts which extend back to the main transmission at 90 deg angles.

The main transmission box and the six shafts which lead from it are conventional Sikorsky standard dimensions apart blocks in direct outgrowth of the S-64 program. The extended gear boxes, the main structural members of the blade reinforcement, steel structural ribs extend along the leading edge of the blade spar to give chordwise static load carrying. Leading edge of the blade is an aluminum skin section with rib supports and a main chordwise support structure which attaches to the spar of the main spar. Skin (system) has a drive which is attached to the spar by an adjacent load.

Main gearbox is a transaxial gear design developed for the S-65. It employs double planetary reduction gears to reduce the engine input shaft speed from 6073 rpm to a main rotor shaft output at 185 rpm. Engine gearbox effect is primary reduction of about 2.4 from the 13,000 rpm output of each engine.

Transmission gearbox, which will still gear manufactured by Indiana Gear Works, is designed for a maximum

## UNDERGROUND CORROSION PROBLEMS?



Moisture and condensation corrosion problems on steel buildings may be solved with Rust-Oleum's new development: special seal coatings to help you solve these problems. Rust-Oleum spray-on moisture shields to work, build-in with you and your organization. May we hear from you?

**RUST-OLEUM CORPORATION**  
1000 North Broad Street, Pittsburg, Pa. 15139

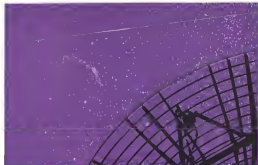
Rust-Oleum (Holland) N.V.,  
P.O. Box 100, Rotterdam, The Netherlands

See Rust-Oleum  
in this ad

See Rust-Oleum  
in this ad

**RUST-OLEUM**  
**STOPS**  
**RUST!**





## SPACE MISSIONS IMPLEMENTED FROM THE GROUND ON UP

From ground command and control to the building of payloads—ITT is a participant in virtually every area of the nation's space effort. / As ITT company is the prime contractor to DCA for systems engineering of the entire DEFENSE COMMUNICATIONS SATELLITE program ITT is active in satellite payload programs—providing total packages (ARMY GEODETIC SATELLITE)—communications and component subsystems (DARWIN, S-62, S-63, S-64, S-65). As ITT division is totally responsible for ground communication systems for all AEGIS bases. Is a wide variety of missile programs—including MINUTEMAN, TITAN and POLARIS—ITT has designed and built communique flows, firing, launching, guidance, tracking, recording and control equipment. ITT companies provide ground communication stations for Project RELAY, communication satellites and checkout procedures for Project MINICURY. ITT range support and electronic design experts contribute to the operation of the ATLANTIC MISSILE RANGE, the PACIFIC MISSILE RANGE, and AR15 (Advanced Range Instrumentation Ship)—and other range projects of NASA, US ARMY, NAVY and AIR FORCE. / International Telephone and Telegraph Corporation, World Headquarters: 300 Park Avenue, New York 22, N. Y.

DESIGN, DEVELOPMENT AND MANUFACTURE OF ALL SYSTEMS AND SUBSYSTEMS. DESIGN, BUILDING, MANUFACTURING, MAINTENANCE, REPAIR, MODIFICATION OF COMMUNICATIONS SYSTEMS AND EQUIPMENT. TELEVISION, VIDEO, AUDIO, RADIO, SATELLITE, AND OTHER COMMUNICATIONS SYSTEMS. DESIGN, BUILDING, MANUFACTURING, MAINTENANCE, REPAIR, MODIFICATION OF COMMUNICATIONS SYSTEMS AND EQUIPMENT. DESIGN, BUILDING, MANUFACTURING, MAINTENANCE, REPAIR, MODIFICATION OF COMMUNICATIONS SYSTEMS AND EQUIPMENT.

# ITT

angle-cages, provide 5,200 dhp, or a combined-cage component of 4,600 dhp. This will enable the GH-51A to use growth versions of the T-64 engine without major design change.

Development of the GH-51A design, the first to be constructed in Navy's new Integrated Maintenance Management Program, from its inception (AVF Feb. 4, p. 92) stresses reliability and maintainability. These two considerations dictated to some degree the placement and design of such components as the engines, fuel cells, auxiliary power plant and the engine accessory units.

Features of the engines, for example, reduce the chance of both vibration and/or resonance damage from ground fire, since the fuelage and the main transmission being shielded each engine from opposite side fire. Streamlined components, which extend from each side of the fuelage at flow level, also provide some shielding from below.

### Fuel Cell Location

The auxiliary bus fuel cells are located in the forward section of each spar, which also house the main landing gear assemblies, and are supported by glass fiber lamin and nylon lining. The lower one third of each cell is self-shielding and their location on opposite sides of the fuelage reduces the chance of both being hit simultaneously.

Fuel cells are interchangeable and can be quickly removed by opening access panels on the top of the spar. The fuel system, which is a negative pressure injection system, can operate efficiently from either or both cells. Low key line pressure, which will remain below 50 psi, permits use of flexible plastic fuel lines.

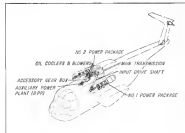
Fuel system employs two engine-driven pumps which evacuate the fuel lines. Fuel is forced through the system by atmospheric pressure. Main advantage of the system is the lack of fuel pumps in the tanks or sumps, which makes the system less vulnerable and easier to maintain. Echostrons and low-pressure lines also would not heat and spray fuel around the aircraft if perturbed.

Radiation shield, powerplant, which consists of a Solar T62T-12 gas turbine engine with a Solar starting system, is located on top of the fuelage ahead of the main transmission. It is covered by the forward extension of the transparent lining. In this location, the unit, which provides power for main engine starting as well as ground operation and checkout of all of the aircraft's hydraulic, electrical and electronic systems, is shielded by the fuelage below and the engine nacelles on each side.

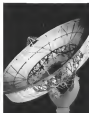
Hydraulic, pneumatic and electrical accessory units, which are located in the forward section of the fuelage and the engine nacelles.

Typical of the accessibility considerations in the GH-51 design are the nacelles, which consist of a series of hinged panels that act as structural members when closed. The panels, each reached from a work platform which folds out of the frame opening, bearing 360 deg accessibility to the engines.

Engine accessories, such as the fuel pumps, that require periodic maintenance have all been located on the underside of the engines. These are at chest level on an average and can reach below 50 psi, permits use of flexible plastic fuel lines.



CN 32A POWER TRAIN and auxiliary powerplant installation are shown.



to  
turn  
a  
haystack

■ 4 Acramine/22 hydraulic servo motors orient the Haystack antenna at North Tyngsboro, Mass. in azimuth and elevation.

■ If your project requires controlled movement with quick response at slow speeds, write to Cimrel Division, The Cincinnati Milling Machine Company, Cincinnati 3, Ohio. Ask for Publication M-2281B.



Acramine/22 Motor  
Cincinnati Milling Machine  
Weight: 150 lb. Capacity: 120 in. lb.

CINCINNATI



Accent  
on  
VALUE



New hermetic

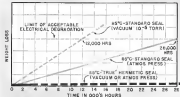
seal... new capacitor life

Now, to the inherent advantages of foil-wound capacitors, General Electric adds a true hermetic seal. It employs a special glass which is bonded to insulation inside by a recently perfected process.

As shown above, this new seal increases the life of foil capacitors by virtually eliminating electrolyte loss. Combined with the high-voltage, high-moisture, and self-healing characteristics of foil capacitors, this added life makes G-E 500 Translytic\* units extremely well suited for use in missiles, satellites and other electronic systems where high reliability is required.

**Outstanding advantages of the glass seal:** over a seal of organic material a foil glass will not outgas when exposed to vacuum or oxidation. Glass is more stable to the chemical action of electrolyte, too. Both features reduce the possibility of contamination vapors entering surrounding equipment, and improve capacitor reliability.

CAPACITOR DEGRADATION RESULTING FROM ELECTROLYTE LOSS



NOTE: SOLID LINES—ACTUAL DATA, DOTTED LINES—ESTIMATED DATA

In developing the hermetic seal, General Electric has had the support of North American Aviation's Aerospace Division as a part of the program to develop High Reliability equipment for the Air Force, Navy, and Army. More recently, U.S. Army Electronics RND Laboratory awarded G.E. a contract to support development of a hermetic seal for standard foil capacitors.

**Ratings of the new hermetically sealed capacitors:** are 65°C and 125°C, 15 to 100 volts, and 75 to 600 microfarads. They come in 5 case sizes, of polar and non-polar construction.

Ask your General Electric Sales Engineer about the units now available from stock for prototype work. We'll be happy to meet you with applications, too. For more information, write for Bulletin GEA-7654, to Service 420-56, General Electric Co., Schenectady, N.Y. 12301. Or contact your Capacitor Product Division, Room 3 C.

\* See your stock of General Electric Co.

Progress Is Our Most Important Product

GENERAL  ELECTRIC





## Army XV-5A\* provides maximum range/payload

Scheduled to fly in mid-1963, the Army XV-5A\* lift fan aircraft will provide greater payload/range capability than any other high performance V/STOL system.

Now being designed and built by Ryan Aeronautical Company, under contract to General Electric, the XV-5A\* aircraft will be powered by two J85 jet engines which drive submerged wing fans for vertical flight. This unique concept provides two to three times more lift, for a given amount of installed engine thrust, than any other high speed V/STOL design.

Result: Greater payload/range capability—less fuel consumption and need for logistic support. Because the lift fan system multiplies engine thrust by 300 percent, for vertical flight, XV-5A\* engines can be sized for most efficient hovering and cruise conditions and do not have to be oversized to meet V/STOL flight requirements. These inherent and designed advantages give the XV-5A\* performance which meets anticipated requirements for military missions.

\* FORMERLY X-21C

RYAN AERONAUTICAL COMPANY, SAN DIEGO, CALIFORNIA

**RYAN**  
AEROSPACE

RYAN'S SPECTRUM OF CAPABILITIES



Conventional XV-5A\* cockpit permits pilots to fly through transitions without moving hand or foot control positions



Low velocity and low temperature lift fan effort provide major advantages for operation from unprepared sites

### CH-53A Specifications

#### Dimensions:

Overall length with rotor open: 64.1 ft.  
Overall length at main rotor fold: 35.8 ft.  
Overall width with blades folded: 45.5 ft.  
Main rotor diameter: 73.8 ft.  
Tail rotor diameter: 27.0 ft.  
Wing span: 31.4 ft.  
Wing chord: 13.5 ft.  
Crew weight: 31,414 lb.  
Crew load: 17,314 lb.  
Payload on external cargo load: 5,000 lb.

Performance:  
Max. speed at sea level with main rotor folded: 179 kt.  
Cruise speed at sea level with main rotor folded: 170 kt.

Hourly fuel consumption with main rotor folded: 2,200 ft.  
Cruise fuel consumption with main rotor folded: 1,000 ft.

Hourly fuel consumption with main rotor folded: 2,200 ft.  
Cruise fuel consumption with main rotor folded: 1,000 ft.

Hourly fuel consumption with main rotor folded: 2,200 ft.  
Cruise fuel consumption with main rotor folded: 1,000 ft.

Hourly fuel consumption with main rotor folded: 2,200 ft.  
Cruise fuel consumption with main rotor folded: 1,000 ft.

range from five to eight miles and all doors and rotors fold in a quick descent without attachments. Engine control levers are arranged for easy panel look-up.

Engine air intake ducts on the nacelles are wedge-shaped and contract the engine air flow around the engine drive gear boxes and intake tubes to the front face of each engine. Horsepower loss computed for the ducts is less than one-half of 1% when the aircraft is in level flight, and the ducts are closed when the aircraft is in steep climb.

#### Cooling System

The nacelles have been designed with a cooling system to maintain consistent engine temperatures during climb, cruise, descent, and level flight and to prevent "hot spots" temperature buildup after engine shutdown.

Sensors are in inlet louvers, located on the lower forward section of each nacelle, which act in conjunction with an exhaust duct at the rear end to maintain a flow of cooling air through the nacelle. Reductive-brake lever on the main cooling surface also helps to prevent compressor back-blowing through the exhaust. Servo levers on the upper rear nacelle pinch permit free

convective cooling after engine shutdown.

Wings are provided along both sides and along the top of the fuselage, to give extra lift in all units enclosed in the main transmission housing. The final section, which carries the main transmission, slides forward exposing the rotor and

The main transmission units are located directly behind the main transmission and drive the main transmission. A gear box driven by the main transmission slides forward to expose the rotor and

Located on the rear section of the fuselage is a 600,000 lbs. heater for cabin heating and an engine oil cooler. Large access panels also have been provided for these units.

#### Rotor Head

Transmission and main rotor shaft are connected via access panels on each side of the transmission housing. The rotor head, which has an automatic blade-folding system and a blade positioner that sets the rotor head in the correct position for the folding sequence, can be reached from the fuselage, without the use of blades fold back on top of the fuselage.

Tail rotor is a four-bladed, semi-rigid configuration. It is driven by a

shaft which runs from the main transmission along the top of the fuselage to an intermediate gear box at the base of the support portion of the rotor. A secondary shaft runs from the intermediate gear box to the rotor gear box atop the rotor.

#### Carrier Storage

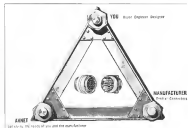
Tail rotor is hinged about 5 ft. forward of the support portion and folds automatically as part of the blade folding sequence. The rotor also can be folded separately with a hydraulic mobile pump, to lower the tail rotor assembly for inspection or minor maintenance.

Blade and tail rotor folding extends the helicopter's length to 50.5 ft. for storage aboard an aircraft carrier. Minimum width is achieved from the main rotor diameter at 37.5 ft. to store in hangar bays 37.5 ft. high.

The CH-53A's main transmission is divided into five main sections: the engine, forward rotor section, all other sections, tail rotor and the main rotor.

Overall fuselage length from nose to tail pylon tip is 67.2 ft. The rotor is a constant speed 30 ft. long 6.5 ft. high and 7.5 ft. wide.

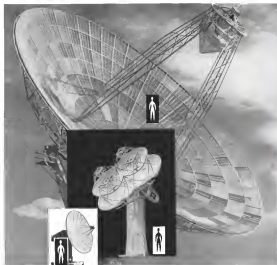
The rotor head is built with support for 100 ft. constant 5,000, 10,000 and 20,000 lb. capacity tandem fittings



Avnet service is strong, solid ....







## AT RADIATION, IDEAS BECOME REALITY

*Example: Antennas of diversified design*

An effective antenna must provide far more than a sum of its parts for maximum efficiency; it must be considered an integral part of an entire system rather than an individual component. That's why Radiation engineers experienced in complete system development consistently base final design parameters on ultimate application. The success of this system-oriented approach is evidenced by scores of Radiation antennas sweeping the skies from the Pacific to the Atlantic Missile Ranges.

Thus, Radiation has developed more experience in automatic tracking antenna design and application of telemetry techniques than any other company. A 12 foot dish antenna, tracking near 40 individual tracking servo systems and made switching legs, is now under development for the X-29 (Edge) Board program. Two 400-gal., wideband 85-foot antenna systems will soon be put into service on the Atlantic and Pacific Missile Ranges. Radiation quad-helix array antennas with

phase monopulse tracking have been delivered for the Telstar Project. And now, Radiation's broad-band "Telstar" antenna is available. Telstar combines acquisition and tracking operations for telemetry, surveillance and communications and operates from 205 to 2,500 Mc.

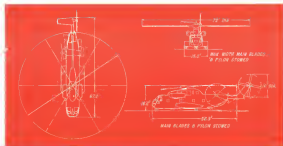
These examples illustrate Radiation's unique contributions through advanced research and production techniques. If your interest lies in this field, you'll find a challenging and rewarding future at Radiation. Write for more information or send your resume to Personnel Director, Dept. AW-4 Radiation Incorporated, Melbourne, Florida. Radiation is an equal opportunity employer.



**RADIATION**  
INCORPORATED

A Division of Radco Inc. Incorporated

Ground/Telemetry/Intelligence Handling Systems—Antennas—Chassis—RF Systems—Manufacturing



THREE VIEW DRAWING shows CH-53A ground management. Dotted lines in top and side views are main blade and tail rotor positions after folding. Note lobby shaped engine exhaust in front view. Main rotor is tilted forward 3 deg.

spaced 28 in. apart in the landing boxes.

Seating arrangements for 25 cockpit equipped troops, a crew chief and a troop commander regardless of use, called for in the specifications, but one of the changes proposed by the working review team was to increase that to a total of 28 passengers. Cabin seats also will be capable of holding 24 soldiers later and four medical attendants with transportation of wounded.

The person manning the CH-53A will be cargo loading, however. The main objectives of the crew chief, the upmost tail rotor, and the integrated cargo loading system were designed specifically for this mission.

The new cargo door consists of two horizontal panels, the upper of which swings in and up to give a circular clearance. The entire swing downward is in a loading ramp. The hydraulically operated ramp can support 1,600 lb above extended horizontal at the fuselage floor level. This permits loading cargo directly into the landing from truck level.

### Cargo Handling System

Two tracks, divided into 10 ft. sections are set in floor elements to support wheeled vehicles. The track sections have four rollers on the underside and can be flipped over to form a double roller track for loading boxes or pallet loads.

Steve Monroe, Corps specification call for all aspects with a three-minute crew—light, simple and crew chief—a man which integrated cargo handling system with a crew-chief control cable was

built into the landing. The system consists of two 2,000-lb. capacity winches set in the forward corners of the cargo compartment. The winches can be operated singly or in unison and can be used to both load and unload cargo. The antenna control cable is stored on an overhead, spring-mounted reel near the rear door. This enables the crew chief to run cables out to boxes or pallets behind the landing and 400 meters around the perimeter.

Specific items the CH-53A is designed to carry include:

- One 41 ton truck and trailer.
- Heavy duty traffic on its trailer.
- 100 ton, loadable air one 5-ton jeep with a 1-ton tow-behind trailer.

Guaranteed performance of the CH-53A at maximum takeoff gross weight of 13,450 lb is 170 kt at sea level. Normal cruise speed is 190 kt. Heavy cruising out of ground effect is 7,200 ft and combat radius is 180 miles. Rate of climb is one minute a 100 feet per second.

Avionics' landing gear consists of three retractable, wheel-wheel units, one in the nose and one in the aft section of each section. Tires are 5.00-16 tubeless.

Nose gear, which can rotate 360 deg. on the ground, retracts forward into a wheel well in the bottom of the fuselage. The main gear assemblies retract forward into compartments in the fuselage. A tail rotor, which extends from the bottom of the tail pylon, where the gear is located, provides protection for the tail rotor during the landing flare. The tail automatically retracts when

lift landing pressure is exerted on the main landing gear, leaving the air under the pylon clear for landing and take-off operations.

CH-53A also has emergency inter-landing capabilities. The entire bottom of the landing is watertight and the spars provide an additional 2,500 lb of buoyancy. Spars also provide roll stability, enabling the helicopter to remain afloat for a minimum of two hours with its gear off.

CH-53A's flight control system is composed of mechanical linkage units connected to three banks of hydraulic lines, a primary and a backup to handle flight loads and a third set to operate the automatic flight control system. Primary control controls roll, pitch, yaw and altitude. Backup control controls roll and pitch only. System permits hands-off attitude, individual and as a backup rear flight in a maximum dynamic stability.

### Control System Operation

The system operates through attitude and rate sensing, cyclic stick position sensing, electronic damping and angle detection and it directs front for control surface movements. The system can be engaged prior to takeoff and left engaged during flight. It has built-in automatic which permits stability on carburetor and allows the pilot to assume control of the helicopter through manual use of the manual controls at any time during flight.

Avionics' electrical power system consists of two isolated circuits, each producing 115/200 v, ac or 28 v, dc power. The generators are mounted on



# OPPORTUNITIES IN SYSTEM TECHNOLOGY

Structural Dynamics

Aerodynamics

Thermodynamics

Operations  
Analysis

Propulsion

Weights



Guidance and  
Control

Strength

Loads

## "Task Force" Engineers

### SPEED—MCDONNELL AEROSPACE DEVELOPMENT PROGRAMS

System Technology Division (STD) engineers at McDonnell provide "Task Force" support for all McDonnell systems engineering. These teams of technical specialists are assigned to specific engineering programs to advance the design and development of space, missile and aircraft products. While so assigned, they continue to receive technical and administrative direction from their functional department within the System Technology Division.

This "Task Force" approach facilitates rapid build-up of engineering effort without re-organization or disruptive administrative changes. Since STD engineers operate in all company design areas, the organization provides an effective avenue for

interchange of ideas and developments between all McDonnell engineering divisions.

A number of this team achieves a high degree of product diversification experience which increases his capability in his particular area of specialization. When a project is completed, the STD engineer is assigned to a new program. In this way, the creative talents of these key specialists are continually applied to the most critical engineering projects.

If you are interested in the diversified opportunities inherent in the McDonnell System Technology Division, complete and mail, in confidence, the brief resume form below. For a comprehensive, immediate review of your qualifications, attach a complete resume of your education and experience.

the necessary gear box and air driven by the open rotor transmission. The rotor lighting consists of position lights, anti-collision lights on top of the pylon and on the bottom of the nacelle, four 450-watt landing lights and three 150-watt flood lights. Two 400-watt lights on each side of the cabin and one on the under side of the tail pylon, provide light for the cargo loading area. Flood light out, which casts a fine light beam from above for illumination during take-off, is provided.

The electronics packages include the internal COM and NAVICOM communications, navigational system and a radar identification set (IFF). Special equipment includes an AN/APN-117 radar altimeter and an AN/ARN-82 TACAN radio navigation set. Space weight and power provisions also have been made for future installation of an AN/APN-130 radar navigation set, an AN/AYK-3 navigation computer group and a PT-429-A tactical display, plotting board. Electronics packages are stored in one partition on either side of the aisle-way.

Navy has an integrated weapons package under development, but it will not be ready for installation in the first production CH-53. Provision will be made for accommodating the integrated package.

Crew and passenger safety has been taken into consideration in the CH-53 provision made for future installation of ejection seats and life rafts outside the cabin and cockpit area. No provision has been made for installation of ejection seats, because the open rotors do not cut off air. However, such provision has been kept in mind, according to design engineers, especially for nonstandard weapons which could provide ejection for the troops leaving the rotors.

A total of 11 emergency escape seats have been provided, four in the cabin and two in the cockpit.

### AFOSR Awards

Air Force Office of Scientific Research recently awarded grants and contracts totaling approximately \$4.5 million to universities and research centers in the United States and Europe.

#### Grants

Stanford University, Stanford, Calif.—\$1.75M for investigation of development of the Langmuir oscillator—F. B. Bostedt, Dept. of Physics, Stanford University.

University of California Berkeley, Calif.—\$1.45M for program of research in study of transverse waves—J. D. Joannopoulos, Dept. of Physics, University of California Berkeley.

New York University, New York, N.Y.—\$1.1M for research in study of nonlinear phenomena in nonlinear systems—J. P. Boyd, Dept. of Mathematics, New York University.

N.Y.—\$1.05M for study of the dynamics of plasma systems—J. D. Joannopoulos, Dept. of Physics, Stanford University.

University of Illinois, Urbana, Ill.—\$1.05M for studies in nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Illinois.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Chicago, Chicago, Ill.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Chicago.

University of Michigan, Ann Arbor, Mich.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Michigan.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

University of Wisconsin, Madison, Wis.—\$1.05M for study of nonlinear wave interactions—J. D. Joannopoulos, Dept. of Physics, University of Wisconsin.

### Putting the lid on a big one

At last here is shown how to lower cost and risk of the new, more complex, multi-stage rockets in the recently completed Space Shuttle. The General Electric Space Technology Center, Valley Forge, Pennsylvania, has designed and installed the thermal shield, heat sink-like skin on the nose, under the lid—crucial and essential component of the entire rocket, which is the lid. This is the first lid we've had, but we've had a new, more complex, multi-stage rocket and a certainly won't be the last. We helped place a new lid in the engine compartment in many of the satellites now in orbit, as well as other structures that have been designed and built by GE.

A GE's experience goes even beyond design, systems, however, it includes responsibility for the design, development and testing of many programs. Why not take advantage of the wealth of experience—write today.

**GE**

**General Electric**

**Space Technology Center**

**Valley Forge, Pennsylvania**

Send This Form To: D. F. Waters, McDonnell Employment, Dept. 684, Box 516, St. Louis 65, Mo.

Name \_\_\_\_\_ Home Address \_\_\_\_\_

City & State \_\_\_\_\_ Phone \_\_\_\_\_ Age \_\_\_\_\_

Education: BS \_\_\_\_\_ MS \_\_\_\_\_ PhD \_\_\_\_\_ Major Field \_\_\_\_\_

Present Job Title \_\_\_\_\_

I would like to receive a copy from ☐  **MCDONNELL** an equal opportunity employer

McDonnell is an Equal Opportunity Employer













## Opportunities in Design & Development of Advanced Turbine Engines for New ASW and V/STOL AIRCRAFT MOBILE NUCLEAR REACTOR

Military limited warfare concepts have established urgent requirements for new gas turbine engines with greatly extended capabilities.

Allison—longtime world leader in Turboprops—is now developing new engines to meet advanced requirements for ASW and V/STOL types of aircraft. These include a thermal regenerative turboprop which would save three triple on station time for an ASW aircraft. In addition, Allison is

studying optimum turbine engines for a highly mobile Military Compact Reactor it is developing for the Atomic Energy Commission.

Acceleration of these and other solid, advanced turbine engine development programs creates immediate opportunities for engineers and scientists—BS & MS—experience preferred: MECHANICAL ENGINEERS . . . ELECTRICAL ENGINEERS . . . AERONAUTICAL ENGINEERS . . . CHEMICAL ENGINEERS . . . METALLURGISTS . . . MATHEMATICIANS. Work areas include:

- STRESS ANALYSIS
- MECHANICAL DESIGN
- AERODYNAMICS
- CONTROL ENGINEERING
- THERMODYNAMICS
- DEVELOPMENT ENGINEERING

Positions involve work in design and development of all types of advanced turbine engines and components including new compressors, turbines, reduction gear assemblies, turbo machinery for industrial use, etc.

A promising future awaits those who qualify. Send your resume TODAY, or write to: Mr. V. A. Rhodes, Professional and Scientific Personnel, Dept. 1304, Allison Division, General Motors Corporation, Indianapolis 6, Indiana.

An equal opportunity employer

**Allison**  
THE EXTENSIVE CONVERSION DIVISION OF  
GENERAL MOTORS CORPORATION, INDIANA



# Destination: EARTH

After a final over-the-shoulder glance at the craggy lunar seas, moon explorers will apply their selves to the new task at hand—getting back home. Here will the lunar destination at time of lift-off be coordinated with earth landing site, home site of flight and landing range from re-entry at  $\gamma = -6^\circ$  to touchdown.

### Curves Provide Key

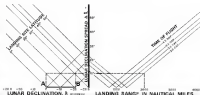
The curves on upper right provide the key. Window AB describes the range of lunar declinations, from  $+0.1^\circ$  to  $-24.5^\circ$ , acceptable, but remaining so on earth landing site at a latitude of  $+10^\circ$ , for a 2.5 day time of flight with a landing stage of 2000 m as from re-entry at  $\gamma = -6^\circ$  to conclusion. The schematic, elsewhere shown, is the trajectory plan, for a lunar declination of  $-10^\circ$ . As lunar declination varies through the acceptable range shown in the curves, the trajectory plane will rotate around the radius from earth center to landing site.

### Variety of Opportunities

At Astronautics, we are deeply involved with a great variety of space related activities. These include the design and development of boosters and vehicles to accomplish for ongoing missions as well as the analysis of the paths they will follow. While developing the precise electronic systems that will guide, track and communicate with the men and machines that fly along our way, we are also creating a number of opportunities for engineers and scientists with exceptional abilities. If you are serious and experienced, qualify you to fill one of these positions in advanced areas of aerocopy, we urge your inquiry.

### Details for Engineers and Scientists

You will find details of current positions on the next page. Your reply, which will be held in complete confidence, can be made on the attached Professional Placement Inquiry form or by writing Mr. R. M. Smith, Chief of Professional Personnel and Personnel, Mail Room 130-90, General Dynamics Astronautics, 9850 Kearny Villa Road, San Diego 12, Calif.



LUNAR LIFE OFF AT  $\gamma = -10^\circ$ . Heading for an earth landing site latitude of  $+10^\circ$ , a vehicle will describe the approximate trajectory over a 2.5 day time of flight. Landing within 2000 m of the earth would allow some 2000 m as the way.



RE-ENTRY MINUS 60 SECONDS. The photo will present the aspect in reentry upon capsule's day, near their destination. The photograph was taken at an altitude of 100 miles from a NASA Mercury capsule boosted into orbit by an Atlas space launch vehicle.

**GD**  
GENERAL DYNAMICS CORPORATION

**GENERAL DYNAMICS | ASTRONAUTICS**



Important positions exist in the following areas:

**DYNAMICS  
ENGINEERING**

BS or MS in aerospace physics or math with two or more years experience and leadership with the application of aerodynamic and dynamic computer techniques for aircraft in the following areas:

**FLATABILITY AND CONTROL:** in conduct theoretical studies on the aerodynamic of large span transport and space vehicles. To determine stability and dynamic response of space vehicles in the presence of payload trim, twisting, linear bending modes, and non-linear servo characteristics. Must be familiar with control and systems techniques for modeling and evaluating control system parameters. Background in theoretical dynamics is required to analyze control system environments and general dynamic behavior of space vehicles.

**STRUCTURAL DYNAMICS:** in determine response of an elastic space vehicle in non-axisymmetric such as atmospheric conditions, elastic spinlock, vehicle jacking. Openings also exist in stability whereas research team build upon the structural dynamics of composite and systems and for monitoring state of composite in solid dynamic models of space vehicles, including impact of test plans, micro-mechanics analysis, testing, testing, etc.

**ADVANCED  
ELECTRONIC  
SYSTEMS**

Assignments are in such projects as space bioscience, advanced telemetry systems and payload packaging. Experience desired include advanced design and analysis of systems as payload, communications, telemetry, data processing systems, antenna systems, or electronic ground support systems. An advanced degree is desirable.

**STRESS  
ANALYSIS**

Openings are required to perform stress analyses on advanced aircraft and space vehicle designs and associated ground support systems. The development of stress analysis standards and test design for evaluation of structural integrity are additional tasks in this area. BS or MS degree and at least three years of experience in stress analysis are required for these positions.

**ELECTRICAL  
ENGINEERING**

BS or MSET with applicable experience required for assignments in designing control systems, propulsion, test equipment, remote electrical power systems or computer-aided systems. Openings exist in design, development, testing, evaluation, selection, and use of ground and airborne electrical equipment.

Openings also exist for graduate engineers in the following:

STRUCTURAL DESIGN, RELIABILITY, MAINTENANCE, OPERATIONS AND SYSTEMS ANALYSIS, WELDING ENGINEERING, MECHANICAL DESIGN, STANDARDS, and TECHNICAL WRITING.

**THERMODYNAMICS  
ENGINEERING**

BS or MS or ME or AE in developing design criteria and methods. Development of models on the basis of thermodynamics. Particular consideration on rocket engine, heat exchangers, or low speed and aerothermal heat sources. Should have two years of experience.

**INTERNAL GUIDANCE**

BS degree in physics, BS or ME or MS in 1 year of experience in one or more of the following:

**TECHNICAL ANALYSIS:** scope includes establishment of guidance and flight control system requirements, analysis of system performance, establishment of test parameters and methods of design changes.

**SYSTEMS DESIGN:** work in the design and development of the Control space vehicle flight control system. The system includes the complete programming, design, and testing of the guidance system. The design is also responsible for design of sensors or test equipment.

**GUIDANCE TEST:** require individual with design and laboratory experience for subassembly control and in some cases the development of test systems to evaluate and include. To achieve this goal, the skills must have good and good skills in configuration control.

**DESIGN ASSURANCE  
AND RELIABILITY**

Responsible including applied supervisory and individual conductors in all levels of performance and evaluation of systems with design backgrounds in either design engineering or technology in both.

Tasks exist in **TECHNOLOGY DEVELOPMENT** is the following:

**SYSTEMS:** Open-System Analysis, Reliability System Design, System Analysis, Models, Cost Effectiveness, Reliability, Man-Machine Systems, etc.

**COMPONENTS:** Reliability Hardware Design, Hardware Analysis, Evaluation, Computer Evaluation, Test and Material Selection, Performance Criteria, Supply Program and Evaluation.

Openings exist in the experimental research with applied higher education research primarily to maintain the design required, higher degree preferred. Career analysis with research and design experience is also desirable.

**AERODYNAMICS**

BS or MS or AE or ME with experience in aerodynamic studies in beginning to expert level. Flow, calculation of aerodynamic coefficients, and accurate calculations, to perform research and development in the area of flow measurement and aerodynamic analysis. Must have three years experience in aerodynamic analysis.

**EXPLORE THE IDEA** of growth and advancement with one of the nation's premier aerospace firms, a company whose name is synonymous with leadership in a broad range of pioneering industrial activities. Among dozens of active study centers and programs, hardware projects which assure for ongoing challenges to Aerospace and Test engineers are Nova, Cosmos, Atlas SLV III, lunar vehicles, manned space stations, solar powered and an impressive array of testing and space probe vehicles. Consider the scope of these projects. Match your interests and abilities with the activity design projects at JPL. Visualize yourself at the forefront of the professional challenge. Join our staff and the many San Diego climate favors your family's year-round enjoyment of life.



Explore the projects of San Diego JPL.

\*If the inquiry and lead have been removed, or if you wish to forward or request more detailed information, please write to Mr. R. N. Smith, Chief of Engineering, Planning and Personnel, JPL, Zone 130-90, General Dynamics Aircraft Division, 3818 Kearney Villa Road, San Diego 12, California.

**AVIONICS****FAA, ATA Shown Anti-Collision System**

Grant Neck, N.Y.—Laboratory model of an airborne anti-collision system, which is adaptable to a fully automatic collision avoidance system or a less expensive, lighter weight proximity warning indicator, was demonstrated recently by Sperry Gyroscopic to members of the Federal Aviation Agency's collision prevention advisory group and the Air Transport Association.

The Sperry system is a cooperative type that requires compatible elements in both aircraft involved in a collision threat before either is protected, similar to systems developed by Bendix Radio and by the National Co.

Sperry indicates that the fully automatic collision avoidance system (CAS), which evaluates the threat, alerts the pilot only when a hazard exists and shows him the required escape path, may be developed in 1973.

A proximity warning indicator (PWI), which merely displays potential threats and requires pilot evaluation for escape action, is estimated to weigh about 50 lb.

**Stripped-Down Model**

A stripped-down model suitable for smaller aircraft, which would enable them to be "seen" by larger, fully equipped aircraft, is estimated to weigh about 45 lb. The pilot of such a non-equipped aircraft would largely depend upon the fully equipped aircraft performing the required evasive maneuvers, except when the non-equipped aircraft is climbing or descending and crosses a "level-off" plane from the aircraft equipped with the complete system.

Sperry built the current feasibility model under an FAA contract totaling \$160,000, but initiated early work on the concept with company funds. Present contract funds will run out within 60 days and FAA has no present plan to extend the work into flight test phase.

pending results of base computer studies (see box on p. 107).

The Sperry system is the most sophisticated and perhaps the most desirable version of CAS PWI to be developed in 1973. As the complete project nears, the primary problem is not the detection of a potentially threatening aircraft, but discrimination against non-threatening aircraft and selection of the proper escape maneuver when required. The problem of discrimination at the group as well as the CAS PWI concepts have been limited. The events necessary and by Sperry is the degree of altitude that prepared by Bendix Radio for its CAS system.

**Reiter Reason**

The new system employs radio beacon techniques that bear some similarity to those used in the air traffic control transponders, but the latter can not be used for the CAS PWI function. A fully equipped aircraft carries a radio-mounted warning antenna which scans an area of 100 to 150 miles in radius. The antenna is also a receiver, so that it can receive the return signal from the CAS PWI function. A fully equipped aircraft carries a radio-mounted warning antenna which scans an area of 100 to 150 miles in radius. The antenna is also a receiver, so that it can receive the return signal from the CAS PWI function.

When the system developed returns from the interrogating aircraft is received by another equipped aircraft, the altitude of the interrogator is compared with the horizontal altitude of the second aircraft. If the two are approximately the same, the specified altitude ground track, the second aircraft data not reply.

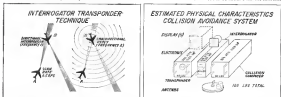
Current thinking is that the altitude ground track would be 1000 ft., except for aircraft that climb and descend at extremely high rates such as military or supersonic transports.

**Message Reply**

If, however, the two aircraft are within 600 ft. of the same altitude, the second aircraft replies with a message containing seven pulses.

This message holds the interrogator's ID, direction in which the second aircraft is flying, and an upward or downward of the north-south and east-west components of its velocity.

In measuring the time delay between interrogation and receipt of the reply, the interrogator's computer can calculate the separation distance, while the position of the returning beacon at the instant the signal is received indicates the relative bearing of the second aircraft. All of this information, plus data on the interrogating aircraft's own heading and altitude, are fed into an analog computer which then determines if the present situation will bring the two aircraft into close enough proximity to constitute a collision threat. The system does not use external aids that constitute a threat but depend upon the accuracy of the two-antenna system, carefully constructed to be about 1 in. for airborne

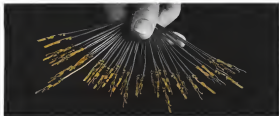


**COLLISION AVOIDANCE SYSTEM (CAS)** usually demonstrated by Sperry Gyroscopic Co. uses interrogator and transponder. Left, in reality to evaluate threat and show pilot required escape maneuvers; direction. However, smaller aircraft could carry only the 40-lb. transponder to make pressure known to fully equipped aircraft, depending upon later to take evasive action. Present PWI indicator of the full weight of full CAS is shown in sketch, right. A lighter weight proximity warning indicator function also is possible.









## The Greeks had a word for it...



## ΕΡΜΑΦΡΟΔΙΤΙΚΟΣ

What this has to do with us is an understandable connection—plainly hermaphroditic and exclusive in the new miniature DUALATCH Connector.

Here's a connector that stacks up a parent industry need with feature after feature—working features that come as a result of our longtime experience and production know-how in seamless termination products and techniques.

In this DUALATCH Connector, the crimped contacts of identical design can be quickly slipped into either half and because the controlled crimping is done on AMP Automachines at rates of up to 1500 terminations per hour, you gain three ways—higher density, maximum reliability and lowest possible installed cost. The flat design of the contact gives you additional advantages over conventional connectors—70% lower insertion and withdrawal forces, overall wiring inches for

greater contact redundancy and better wiring and alignment. Available in 40, 60 and 132 position sizes, the DUALATCH Connector offers these additional features:

- polarized for error-free assembly
- minimum keying possibilities
- 6000 solvent stamped and formed contacts
- AMP Gold over nickel plating
- available for wire size ranges 20/22, 24/26 and 28/32 AWG

Send today for complete information.



AMP Corporation, 300 North 5th Street, P.O. Box 100, Millsboro, Delaware 19966  
 AMP Corporation, 10000 West 16th Avenue, Suite 100, Golden, Colorado 80401  
 AMP Corporation, 10000 West 16th Avenue, Suite 100, Golden, Colorado 80401

### TRANSPONDER REPLY MESSAGE



**TRANSPONDER COMPARISON** also varied altitude with that of intercepting aircraft, or its projected altitude if climbing or descending and ascended only if there is potential threat. Reply indicates altitude difference of third pulse by spacing between pulses two and three. Space between first and third pulses indicates ground speed range of transponder aircraft while spacing between pulses three and six, and six and eight gives transponder aircraft response to north-south and east-west coordinates.

be changed to 16 or 12 microseconds to provide a greater altitude separation ground.

When the interrogator aircraft is involved with a transponder only transponder aircraft which is climbing or descending so that the range parameter is more convenient for the latter, the space between pulses four and five is increased from four microseconds to six to indicate a "levelled" signal to the individual.

The seven-pulse transponder reply message varies the spacing between first and second pulses to show aircraft's speed range (0-300 ft., 0-600 ft. in increments), while the spacing between the second and third pulses tells the interrogator the difference in barometric altitude between the two aircraft. Spacing between pulses three and five and between five and seven tells the transponder aircraft's assigned to a north-south and east-west direction, respectively.

During the laboratory tests here, Sperry introduced various pulses, shaped identical to those used by the interrogator and transponder messages, to simulate the electronic range pulses which would be experienced in a multi-aircraft environment. This produced an increased level false alarms, which quickly disappeared when it failed to overlap with a subsequent interrogation. Theoretical analyses and experimental investigations indicate that as operational CANS systems should expect only a false alarm only once every 60 hr., according to Clem McKinnis, project engineer.

The system in present laboratory configuration uses FBI transponder for the full CANS system, but some modifications may be possible in production design, a company spokesman said. While Sperry is reluctant to estimate price for

## SYSTEMS MEN: CONTACT MITRE

Because of the increasing need for more advanced defense systems, MITRE is expanding its workload.

MITRE's prime mission:

- To design, develop and help put into operation global command and control systems for national defense.
- To analyze and integrate existing systems.
- To design new sensors, communications, and display systems.
- To explore every possible technique that might give the military commander extra seconds for decision and action.

Beginning with RADAR and continuing through EMEWS, NORAD, Concorde Operations Center, Nuclear Detection and Reporting System, and systems get involved. MITRE is making important contributions both to national defense and to systems development.

At MITRE the approach is purely scientific and technological. You work in the leading edge of command and control technology.

Today, at MITRE, there is a broad range of opportunity for component and creative scientists and engineers. You would be part of a team that is doing original, important and challenging work in areas ranging from computer system design to electromagnetic intelligence projects to new computer applications to survivability techniques.

Here we listed the specific assignments now available — and information about how to get started, today, towards a rewarding career at MITRE.

Currently assignments are available in the following broad areas:

- |                         |                        |
|-------------------------|------------------------|
| • Command Systems       | • Advanced Systems     |
| • Data Processing       | • System Cost Analysis |
| • Development           | • Economics            |
| • Computer Applications | • Radar Systems        |
| • Air Defense           | • Radar Technology     |
| • Systems Design        | • Air Traffic Control  |
| • Operations Research   | • Space Surveillance   |
| • Communications        | • Space Systems        |
| • Business Factors      | • Command and Control  |
| • Weapons Development   | • Applications         |

Maximum requirements: B.S. or M.S. or Ph.D. in these disciplines: mathematics, physics, and mathematics. MITRE is located in pleasant suburban location. Rewards are competitive. Write, in confidence, to Vice President — Technical Operations, The MITRE Corporation, P.O. Box 20044, Bedford, Massachusetts.



Founded in the design and development of command and control systems, MITRE was given in 1958 to serve only the United States Government. The independent non-profit firm is technical research and system analysis for the Air Force Electronics Systems Division and also serves the Federal Reserve Agency and the Department of Defense.





Here, at Lockheed Missiles & Space Company's Space Communications Laboratory, scientists are re-investigating the possibility of using the moon to facilitate earth communications. Possibilities for the use of the moon as a relay station for earth-to-earth communications have been largely neglected because the moon's shape and rugged surface greatly distorted a return signal. But Lockheed research into the extension of communications via difficult communications channels, using techniques applicable to dispersive time variant channels, is making significant inroads into this problem. Another new research project at Lockheed is satellite tracking of deep space probes. Since tracking accuracy



depends directly on stations being as far from each other as possible, while maintaining line-of-sight communications, Lockheed is studying the use of two earth-orbiting satellite tracking stations, 3000 miles apart. Not only would ground arrays be greatly benefited by the positioning of the stations above the earth's atmosphere, thus eliminating atmospheric distortion. Examples of other research projects being pursued by Lockheed in the communications area include: Random noise filtering, satellite readout techniques, satellite communications, radar warning, submarine tracking, modulation of optical signals, communications over multipath channels, and learning systems.

**LOOK AT LOCKHEED... AS A CAREER** Consider Lockheed's leadership in space technology. Consider its communications—such as the Polaris missile and the Agena vehicle's superb record of space missions. Consider its outstanding achievements—Lockheed, advancement policies, creative climate, opportunity for individual recognition.

Then write for a brochure that gives you a more complete Look at Lockheed. Address: Research & Development Staff, Dept. M-45B, P.O. Box 581, Sunnyvale, California. Lockheed is an equal opportunity employer.

**SCIENTISTS & ENGINEERS:** In addition to positions in the research and development of communications and optics, other important openings include: Inertial guidance • Orbit thermodynamics • Electromagnetics • Mission & trajectory analysis • Gas dynamics • Chemical and nuclear propulsion • Systems engineering

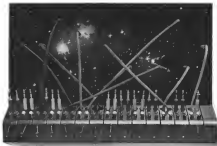
## LOCKHEED

MISSILES & SPACE COMPANY

A member of Lockheed Aircraft Industries Corporation  
Sunnyvale, Palo Alto, Van Nuys, Santa Clara, Santa Monica, California • Cape Canaveral, Florida • Huntsville, Alabama • Hawaii

## LOOK AT LOCKHEED IN SPACE COMMUNICATIONS:

Where outstanding successes have created aerospace leadership



**INTERMODULATION MESSAGE** transmitted by such equipped aircraft consists of two pulses. Atrial of intermodulation message is calculated by spacing two monochromatic beams around each third pulse and between third and fifth pulses. If intermodulation phase is changing or decreasing at very high rate of speed, ranging from about 6000 Hz, pulse space between first and second will be increased. If intermodulation message, after receiving frequency shift, demonstrates that other aircraft is changing/descending into collision threat and does not have full anti-collision status. The intermodulation code changes upon alternate fourth and fifth pulses to tell other aircraft to look out to avoid collisions.

A production CAS is now at this stage, as when spokesman estimated it would cost \$12,000 to \$40,000 per aircraft. A Sperry spokesman said that large open air production runs could be available there in five years after a decision was made to adopt the system—a decision which does not appear imminent.

The FAA at present has no plans to fund additional flight tests of the Sperry system. Earlier the FAA sponsored flight tests of the fluid-mounted beamforming, low-type scanning antenna and subsequently funded construction of the present laboratory equipment. The flight tested antenna operated at 24GHz, but Sperry says a production system probably would be designed to operate at K band.

## 1977C FILTER CENTER

► **Optical Transducer Processing**—New optical transducer recently announced by International Electronic Machines Corp., in which infrared light generated by gallium arsenide, position of the mechanism for transducing energy to second person rather than electronic circuit as in a conventional transducer, opens up the possibility of using a variety of new semiconductor materials with short carrier lifetime. Robert N. Reider of London Laboratories reported at the recent Institute of Electrical and Electronic Engineers conference. The new optical transducer may be able to operate at frequencies as high as those obtained with such transducers,

but it should be less expensive to fabricate, Reider predicted.

► **Computer Reads Hand Printing**—Technique that permits automatic reading of hand-printed alphanumeric characters and is largely unaffected by character size, style, tilt, thickness or position on the paper, was reported to the IEEE by Fred P. Kall, Jr., of Sperry Gyroscopic Co. A general purpose computer can be programmed to recognize character by its contour, number of key units and the presence or absence of sharp angles, Kall said.

► **Monopulse Log Spiral Antenna-Synthesizer**—Lightweight log spiral antenna which combines characteristics and advantages of two patterns over a 10° hemisphere range with constant beamwidth and gain was reported to the IEEE convention by R. W. Logan, Airborne Instruments Laboratory. The original, consisting of a four-wire metal log-spiral arm, usually fed from a series of helical and hybrid couplers, provides a constant polarized pattern with elliptical ratio of better than 2 dB over the frequency range and over a angle of ±60 deg, Logan said.

► **Transistor Sampling Switch**—New mode of transistor operation which permits the use for high-speed analog voltage sampling at rates above 100 Mc was reported at IEEE convention by Samuel Yee of Sperry Gyroscopic Co. Silicon processes this transistor with an  $\alpha$  of static impedance of 1,000 megohms is operated in what Yee terms a "neutral mode" in which both emitter and collector current are directed into the transistor. When emitter current is lowered to small values the collector drop also is very low. Several hundred such switches can be connected in parallel, because of the very high impedance of each device, and operated at a multiposition sampling rate.

► **Spigot Moves Into Microelectronics**—Electron, one of the nation's largest electronic component suppliers, is moving into the semiconductor microelectronics field and hopes to have sample quantities available in the fall. Company actually announced its entry into the thin film semiconductor field.

► **Long-Lived Transducer**—Not a single failure observed during a total of 2,767,768 hr of life testing on the P2251 2N2151 phase silicon transducer array pack unit, despite the fact that 56% of the units were carried out with units operating above their maximum rating of 360 mW at 25°C temperature and less than 35% were operated under maximum rating. Subsequent high-voltage tests show maximum ratings produced only four failures in 1,157,665 accumu-



## IGNITION SUB-SYSTEMS

GO! or NO GO!



Ask for technical information on

- safe/arm devices
- explosion systems
- propellant actuated devices



APT, Channahon, Illinois • San Jose, California  
Telephone (916) 847-0100 • Telex 4401



## POWER SUPPLIES

AND

## LIGHT PUMPS

FOR

# LASERS

Standard model Power Supplies, Light Pumps and Special Diodes are available for prompt delivery. They are designed and built to be readily adaptable to the requirements of almost any laser. Most units have rugged, hermetic mounts with cooling capabilities and are factory-finished in the CEI solid state laser module development. This model line should merely reflect the variety of units now in production.

### POWER SUPPLIES

All models with continuously variable voltage output from 0 to maximum rating. Fast response.

#### General Models

Model 325 - 5,000 volt with output to 20,000 joules.  
Model 330 - 10,000 volt with output to 20,000 joules.

#### Modular Units

Model 305 - 5,000 volt with output to 20,000 joules.  
Model 320 - 10,000 volt with output to 20,000 joules.

### PORTABLE LASER POWER SUPPLY

Model 323 - Compact, self-contained Power Supply and X-ray Source. Voltage continuously variable 0 to 5,000. Output to 500 joules.

### SOLID STATE LASER MOUNTS

4 models available. Choice of air or liquid (oil or water) cooled. Wet, hermetic or dry. Output to 100 joules. Maximum power, 2,000 to 20,000 joules.

### ENERGY STORAGE BANKS

available in units of 1,000 joules for use with the Power Supplies listed above.

### SPECIAL DEVICES...

Model 30-4000 Battery Arc Quench for fast switching.

Model 30-4000 External Reflector.

Model 30-4000 Rotary Drive and Mirror Assembly for "Q" spacing or "Q" damping.

Write for further information

### ELECTRO POWERPAC, INC.

A subsidiary of Hydro-Power Corp.

12 Hadley Street

Cambridge 40, Mass.

total hour, giving a failure rate of 0.15%/1,000 hr, Priden says.

► **Army Seeks Silicon RF Amplifier**—Inducts, proposes for 12-month research effort to develop a universal radio frequency amplifier on a single silicon chip are due at Army Electronics Material Agency, Fort Monmouth, N.J., by Apr. 19. Amplifier is to be designed to perform functions of a video amplifier, narrow-band amplifier, mixer and oscillator. An external crystal can be used for some functions, Army says.

► **Executive Communications**—Recent survey of Southern executives reveals that they spend 90% of their time in some form of communication on company time. Survey indicates that 15% is spent listening, 30% is talking, 15% is reading and 40% is writing. Furthermore, he installed two-way, voice-band units in the cars of its executives to enable them to talk with their offices while driving between any of the company's 16 plants and laboratories in eastern Massachusetts.

► **Stares In The Wind**—Industry observers, remembering that the first signs of semiconductor industry market saturation were price cutting and layoffs of line-level operations are speculating that the computer/data processing field now is reaching a similar situation. Recently, the Teknor Corp. sold its computer division to Digital Data Corp. of Massachusetts, withdrawing from the commercial computer business. Packard Bell Electronics has just announced price cuts of as much as \$7,000 on its P8-150 computer, a reduction of 17%.

from its former \$10,000 price tag. Realtek, the company had cut prices on its expanded memory computers. General Mills, Inc., a computer life entry in the digital computer field, now has decided to withdraw completely from the computer market.

► **Improved Polaris SINS Navigation**—Test of the improved SINS Model-2, Mod-2 inertial navigation system for use on 10 Lulu-class Polaris submarines has been delivered by North American's Aerospace Div. Improvements include a new computer of enlarged capacity with trouble diagnosing capabilities, improved integrating, speed computers and gauges bearing pins with a hermetic drive.

► **Stared on the Dotted Line**—Major contract awards recently announced by various manufacturers include: • **Marlin Co.**, Orlando, Fla., Motorola, Chicago and Radio Corp. of America, Camden, N.J., have been selected to develop a new radar navigation system (RADAN) for the Navy's Albatross-class submarines. Each company contract is for up to \$2 million.

• **Rohde Corp.** of Anaheim, Electron Tube Div., has sold 72 kilotube amplifiers for use in a new long-haul nucleotide laser built by Standard University under Atomic Energy Commission contract. Each tube will deliver 24 megawatts of peak power at pulsed 20 microsecond duration with a repetition rate of 100 pulses per second. Sperry Rand Electron Tube Div. also is building wave amplifier of 24 megawatt kilotubes which will operate at 2,450 mc. Total of 248 U tubes will be used to generate 16-20 billion electron volts.



The "Cherry Picker" machine built 18-20 in place.

The x-ray head is positioned to radiograph a steam weld on the X-40.

Radiograph of steam weld made on "Cherry Picker" rig. Blasting through heavy work joints and a silver-lined area.

## The weld can't come to the X-ray— SO the X-ray goes to the weld



North American Aviation, Inc., Los Angeles Division, designed a "Cherry Picker" for on-line radiography of parts and welds on supersonic aircraft.

Radiographic inspection of fusion welds is so important, North American Aviation designed a mobile x-ray truck. It was quickly dubbed the "Cherry Picker." It can be maneuvered into confined areas, reach up twenty-seven feet and outward twenty feet. An X-15 fuselage or airplane's wingpan panel can be examined without being removed from the working jig.

Radiography is increasingly important in proving the soundness of welds, of castings, of controlled assemblies. Compared large and small rely on radiography for assurance that only high-quality work is delivered—highly important in maintaining the kind of reputation that attracts and holds business. It can seek for you a Kodak Technical X-ray Sales Representative call.

NOW . Ready Pack in ROLLS and SHEETS—KODAK Industrial X-ray Film, Types AA and M in listed sizes.

- No darkroom, loading—film loaded in light-tight cassettes.
- Just place Ready Pack in position and expose.
- Film protected from dust, dirt, light, and moisture.
- In the darkroom, remove film from envelope and process.

EASTMAN KODAK COMPANY  
X-ray Sales Division • Rochester 4, N.Y.

KODAK  
KODAK SAFETY FILM





## Scott put the **LIFEGUARD** on the "Vigilante"



Scott life support components for the A-7 are integrated into the compact, individual crewman's survival kit assembly.

The pilot and bombardier/navigator in the Navy's A-7 "Vigilante" attack bomber are protected at all times with SCOTT Lifeguard equipment. Scott provides the pressure control and oxygen system that supports the Navy's life-pressure main train by both crewmen, automatically controlling ventilation throughout the entire profile of the mission. Built-in emergency capability takes over automatically in the event of ship's oxygen supply loss or air crew ejection. During ejection sequence, the Scott survival kit system rides with the man until safe altitude is reached.

The "Vigilante" installation is typical of Scott's capability in the research and development of versatile environmental control and life support systems to meet fast-changing requirements in aviation and aerospace fields.

Find out how Scott can help you meet the challenge in the air and in the space beyond. Send for your copy of the free booklet, "Preparing for Tomorrow—Proficiency on Schedule Today."



### SCOTT AVIATION CORPORATION

DEPT. E-4, LANSING, NEW YORK

Export: Southern Oxygen Company, 3 West 57th St., New York 23, N.Y.  
West Coast Office: Valley View Road, 12011 Redwood Blvd., Studio City, Calif.  
Scott Branch Address: The Walter Scott Company, Ltd.

## NEW AEROSPACE PRODUCTS

### Angular Motion Compensator

Angular motion compensator, Comp-Thema Model AAC-252R, is designed to improve accuracy of manual control system by compensating



for repetitive angular motion errors. Unit has a series of adjustable cam mechanisms that function to produce variable clutch couplings. Device has 16 radial adjustment points at 15-deg intervals. Each point is independent of the others. Unit measures 5 in. in diameter and has a squarish, aluminum, 4-1/2-in. over a total adjustment range of 7 deg.

American Aerospace Controls, Inc., 121 Malibu Blvd., Encinitas, Calif. 92024

### Miniature Hydraulic Pumps

Series 45000 miniature, variable displacement, hydraulic, meter-pump package is designed to supply hydraulic

power for aircraft and space control systems.

The series includes 1, 3, 5, and 7 pattern variable displacement pump designs by 4- or 6-in. modules. A typical unit delivers 0 to 0.15 gpm at 5,000 psi, contains 6.6 in. in length, and



weighs 4 lb. Units with pump displacement as low as 0.005 cu in. per revolution and discharge pressure of 5,000 psi are available.

Overall package efficiency is from 51% to 64% at maximum flow rate according to the manufacturer. Hydro-Air Div. of Crane Co., 3300 Wacker Ave., Berwyn, Calif.

### Air-operated Fluid Pump

Portable fluid pump (CVF) (Dynam) for hydraulic system (check) and other applications develops 10,000 psi fluid



pressure from an air bottle charged to 80 psi maximum.

An air-driven compensating pump delivers two full pumping strokes for each operating cycle to supply fluid. Fluid pressure directly proportional to air pressure can be generated by an air regulator. Operation is automatic once the regulator has been set. Pump operator and discharge pressure is equal to the total force exerted by the large piston of the air motor. When discharge line pressure drops, the pump actuator and returns the pressure balance.

Combination Pump and Valve Co., 874 Front St., Philadelphia 4, Pa.

*our aim is yours too...*

**passenger comfort in flight**



*the Product...*

**AEROTHERM SEATING**

*unsurpassed in the world!*

**AEROTHERM INDUSTRIES, INC.**

BANTAM CONNECTICUT

While Aerotherm is a registered trademark of Aerotherm Industries, Inc., the name Aerotherm is used here under license. Aerotherm Industries, Inc. is not responsible for the use of the name Aerotherm by other companies.





WREN 460 STOL AIRCRAFT (left) can fold-up flaps, ULS control system to achieve short field capability. Note movable vortex generators. *Aviation Week Pilot Report:*

## Control Features Boost Wren 460 STOL

By David A. Bowen

Ft. Worth—Excellent pitch control down to minimum flying speed of 24 mph, coupled with a lateral control mechanism which induces airframe-induced yawing at very low airspeeds, give the Wren 460 bush airplane the capability of operating from 180- to 400-ft landing and takeoff areas.

Flown here recently by the American Wars & Space Technology pilot, the Wren, a short takeoff and landing development of the Cessna 182, showed adequate controllability in all axes through its entire speed range.

Wren embodies a modified version of the non-mounted control surfaces developed by designer James L. Robertson for Army's Transportation Research Command (AW May 25, p. 87) and has

» Cessna Skylane airframe fitted with double-slotted, Fowler-type flaps and a drooped leading edge on the wing. Movable vortex generators mounted

also the wing, and interconnected to the ailerons damp aileron induced yaw when the aircraft is operating in low speed, and they do not noticeably affect its performance at higher speeds.

Wren Vice President Production A. E. Moore flew in the cockpit's seat during the flight from Ft. Worth's Mockern Field. Wind was from the south at 5-10 mph and the temperature was approximately 115°.

Internally, the Wren cabin is identical to the original Cessna. Only change made has been installation of a push-pull control rod from the control column forward through the firewall to



Mounted on aircraft's wing (right).

## Performance

the non-mounted ultra-low speed (U.S.) control surfaces.

Additional instrumentation consisted of an indicator for a Weather Bureau-type anemometer mounted on the right wing strut. This device provided accurate true airspeed readings in the low speed range while conventional airspeed indicators are inaccurate.

Flaps were lowered 30 deg., landing gear set and the 138-hp Continental Q-470-R engine was advanced to full power. Cruise trim setting was used for takeoff.

Brakes were held until some chugging was felt, then released. Positive rotation



VORTEX GENERATORS work only with top-down and are shown in deflated position (left). ULS surfaces (right) attach to the engine mount and are controlled by a single push-pull rod connected to the conventional aileron control system.



DOUBLE-SLOTTED, FOWLER-TYPE flaps (above left) as shown in partially extended position with wing tip raised. Note drooped leading edge of wing. Articulated round ULS surface is shown at right. Three-view (interior) shown dimensions of the Wren.



now began when the accelerometer indicated an upward of 35 g's, and the Wren came off the ground accordingly. Takeoff roll was about 325-350 ft.

Rollers were applied to stop wheel slippage; power was advanced to climb configuration (33 in. Hg manifold pressure and 2,500 rpm) and the flaps were eased up. Flap control is still the original Canova flap-actuated lever. Flap settings on the Wren prototype are 35, 50 and 60 deg, although the flaps are capable of being extended to 70 deg. Production aircraft will have flap settings of 20, 40 and 60 deg.

#### Rapid Acceleration

The aircraft accelerated rapidly as the flaps were raised. With the flaps fully up, the Wren flew and handled much like an unconverted Canova. Roll rates are three to approximately 15°/sec. Roll axis is approximately 15°/sec. Roll axis is approximately 15°/sec. Roll axis is approximately 15°/sec.

Stability after lift off, the Wren climbed steeply with the nose slightly above the horizon. As the flaps were raised, the nose held about the same attitude, but the rate of climb decreased and upward acceleration.

Major divergence from the accelerometer Canova noted during the first few minutes of forward-flight flying was that the lateral control system was quite stiff and an unusual amount of force was needed to turn the control wheel.

This did not reduce the effectiveness of lateral control, but it did make maneuvering the aircraft tenuous. Since the flight, ball bearings have been installed as the aileron system to ease this problem and some of the tension has been taken out of the cables in the wing.

With the flaps up, it was possible to hold the aircraft to about 60 mph and maneuver comfortably. Flaps were then lowered 35 deg and slow flight at 50 mph was attempted. Maneuverability remained good and the aircraft did not feel shaky or excessively heavy on the controls.

With flaps lowered to 45 deg, flight control speed dropped to 40 mph and the feeling of adequate control power remained. Aileron response rate showed tendencies of becoming noticeably slower at this speed, but it remained positive.

With full 60-deg flaps, the Wren maneuvered nicely at 50 mph and could make light 360-deg turns in the 30-35 mph speed range. It was possible to make a 180-deg turn in 11 sec without pulling excessive g

forces and to make a 360-deg turn in 19.5 sec. Turn rates appeared to be about 150 ft.

Considerable maneuvering was done with flaps down, and the speed never exceeded 35 mph. During the slow flight work, the Wren maneuvered tight turn and pitch control and there were no noticeable areas where control surfaces were blanketed out or where control force was provided so low that safety was jeopardized.

#### Stall Characteristics

One man be taken, in fact, to limit the amount of back pressure used on takeoff, since control force is sufficient to stall the aircraft with power on. With power off the aircraft will not stall. Full back pressure on the control wheel with flaps down and power off will set up a slightly nose-high glide at about 40 mph forward speed and a rather high rate of sink. Control response in the glide remains good, especially laterally.

Power stalls were first attempted with flaps up and the engine retarded to 25 in. Hg manifold pressure and 2,000 rpm. The Wren stalled cleanly forward at about 43 mph.

With 15-deg flaps lowered, the aircraft stalled at 33 mph, again forward and with 30-deg flaps, it stalled at approximately 30 mph.

Final stall was with full 60-deg

flaps and the airplane fell through at 24 mph. The Wren was maneuvered at 35 mph (maneuver control was possible by flying with reference to the accelerometer g's in the cockpit, as stated in p. 12), and was fully controllable.

Again, aileron response rate was slower than at higher speeds but yaw tendency was not noted, even when aileron deflections were large.

Of note during the slow flight work was the movement of four strands of wire trailing taped to the right wing strut. Airflow over the struts with full flaps was slow enough so that at times the struts were hanging almost limp. An occasional turbulence gust would turn them forward, but these gusts apparently were not strong enough to affect stability, since they did not disturb the aircraft nor could they be felt in the controls.

#### Wren Loading

Landings were made both into the wind and into a slight crosswind from the left, although the latter was so light as to be negligible.

Aircraft was stabilized at 60 mph as the downwind leg and entered nose high with flaps full up. First 15 deg of flaps was lowered, which caused the nose to pitch down below the horizon. Aircraft then was advanced nose up and no further trimming was needed.



Here at LFC there is plenty of elbow room in which an ambitious engineer or scientist can flex his mental muscles. To move up—not sideways. To achieve positions of higher responsibilities and more authoritative, more rewarding assignments.

LFC is a young company in a still-young industry backed by the enthusiastic support of the entire Lockheed Corporation. And the work is vital. Man always has been power-poor. Now more than ever, as he reaches for the stars, he must climb by propulsion power. As a member of the LFC team, you enter the heart of such advanced programs as:

large solid propellant rocket motors, hybrid propulsion systems, ultra-high performance upper stages for space application, thrust

**LOCKHEED**

vector control and solid propellant research. The Company's location in Southern California provides an ideal growth environment. LFC is located in a rapidly developing aerospace center, only minutes away from two famous universities, and halfway between Los Angeles and world-famed mountain and desert recreation areas.

**SCIENTISTS AND ENGINEERS.** Investigate openings in Visco-elastcity; Design Engineering; Proposal Engineering; Project Engineering; Propellant Development; Chemical Engineering; Thermodynamics, Aerodynamics; Stress and Stress Analysis; Reliability Engineering.

Write: Professional Employment Office, Dept. 5004, E.O. Box 111, Redlands, California. An equal opportunity employer.

**REDLANDS, CALIFORNIA**  
A DIVISION OF LOCKHEED AIRCRAFT CORPORATION

## Wren 460 Specifications, Performance

Performance and specifications of the Wren 460 and the modified Canova 182/50/460 are listed below. Performance figures are for sea level, standard day, full gross weight, unless otherwise noted. Left and top figures in right column refer to 151. Right and bottom figures in right column refer to 160-lb.

	Wren 460	Canova 182/50/460
Empty weight	1,905 lb	1,535/1,635 lb
Useful load	1,205 lb	1,241/1,341 lb
Gross weight	2,810 lb	2,810 lb
No. of seats	4	4
Top speed	48 mph	60 mph
Top speed, sea level	164 mph (164 mph optional)	160/150 mph
Max speed, 75% power, 5,000 ft.	153 mph	150/151 mph
Climax speed, power on	24.20 mph	25 mph
Range, 75% power, 60 gals.	488 mi at 157 mph	485 mi at 150 mph
Rate of climb, sea level	973 fpm	960 fpm
Service ceiling	14,000 ft.	14,000 ft.
Takeoff distance, sea level	340 ft.	621 ft.
2,810 lb gross, 10 mph, wind	310 ft.	
gross weight, no wind, over 10 ft. obstacle	500 ft.	1,200 ft.
Landing distance, ground roll	200 ft.	530 ft.
over 50-ft. obstacle	310 ft.	1,350 ft.
Length	29 ft 8 in.	27 ft 4 in.
Height	10 ft 4 in.	9 ft 6 in.
Wingspan	36 ft 2 in.	36 ft 2 in.
Wing area	175 sq ft.	174 sq ft.

## A frank message to a career-minded engineer:

Ever said to yourself: "The day when a man could get in on the ground floor with an aerospace company and grow with it, is almost gone..."

And you'd be right...almost...but not quite. Because one such opportunity actually does exist.

**LOCKHEED PROPULSION**



Systems Engineers...

## some plain talk about ground floor openings at Honeywell

Honeywell has formed the nucleus of its weapons systems group and is now expanding its capabilities in this field. We have a compact group of experienced men. Hand-picked pros. We need more men just like them. It's an unusual opportunity for you if you qualify. You'll get in on the ground floor with this group just as it's beginning to blossom.

**We think you'd like it here . . . and stay.** Good systems men stay at Honeywell. We have one of the lowest professional turnover rates in the industry—less than half the national average. There are good reasons for it.

### Start with growth . . .

Honeywell's Ordnance Division has grown fast—but steadily and carefully. We've doubled our size every 3 years since 1954. We're not an overburdened young giant, or a one-trick pony.

Our systems men will make major contributions to the continuation of this growth and they know it. What's more, management has committed itself to concrete support of this weapons systems group and its mission. The door is open to you, too, if you're qualified.

### You'll get merit pay and promotions.

Good men like to set their own pace, and Honeywell lets them. We pay and promote to recognize individual performance and progress.

Although we know it's not a primary consideration, our fringe benefits are competitive, too. Honeywell pays full tuition and book costs for advanced degree work. We offer insurance. Retirement. Stock purchase plans, etc.

# Honeywell

An equal opportunity employer

To explore professional opportunities in other Honeywell divisions, contact us, send your application in confidence to Mr. H. O. Eckstrom, Honeywell, Minneapolis 8, Minnesota.

### You'll have professional freedom

That could mean a lot of things in different companies. At Honeywell, it means you're on your own. We hire a man to do a job, not to tell him how to do it. One of the strongest incentives you'd have in tough competition. It replaces the confining supervision you find in many companies.

You'd work with men who recognize and respect good work. You'd operate in a climate of true scientific professionalism.

### Think you would like Honeywell?

The jobs listed below are typical of our present openings.

**Mathematical analysis**—staff engineer—B.S. and Ph.D. in mathematics—3 to 7 years' experience in applied mathematical analysis. Areas of responsibility will include math modeling, air analysis, optimization studies and techniques, simulation and linear programming and digital and analog computer analysis. Knowledge of techniques of military operations, research investigations is most desirable.

**Advanced Systems Development**—staff engineer—B.S. and engineering degree—8 to 10 years' experience related to military tactical fighter field missions, extensive knowledge of Army, Marine, Air Force and Navy tactical problems necessary. A broad technical background in military operations and tactical field requirements is essential. Individual will work closely with engineering management in planning, coordinating, testing, etc. for the weapons system areas.

If you're qualified, write us. Send a brief summary of your qualifications including salary requirements to:

William W. Crovson  
Honeywell Ordnance Division  
610 N. 2nd St.  
Hopkins (Minneapolis), Minnesota  
Or, call him collect in Minneapolis  
at WHat 5-3155

for the balance of the landing approach. More than a second then for a conventional Crusade, but since the time is stabilized for the 15-deg flap setting, it may be designated for the remainder of the approach.

Flap deflection was measured to 18 deg at 400 ft altitude and to 60 deg at approximately 200 ft.

The Wren holds a slightly nose-down attitude during the entire approach, which puts the pilot a good field of vision. Power is held on until the airplane is ready to land and the aircraft is down to the selected landing spot. There is no need to bleed off speed greatly during the approach, since the Wren will hold about 10 mph until.

### Landing Procedure

Power is reduced to idle as the aircraft is stabilized for landing, and there is no tendency to stall. Once the Wren's nose comes up the airplane is committed to an almost instantaneous landing. However, it can be flown out under power any time before the flare begins if the landing has to be aborted.

Pilots will need some time to adjust to the Wren's landing characteristics before they will be able to get the performance the company claims, although the claims themselves are probably conservative. First is the psychological barrier of flying at speeds of 50-55 mph on final approach. After that is overcome, more practice is needed to be able to flare the aircraft and retard the throttle for precise landings.

At 50 mph, the wheels touch, flaps are immediately raised to prevent the Wren from riding with the weight of the wheels, and better air is supplied. Flaring maneuvers can be varied depending on the amount of space available, but fairly fast landing is required for a maximum-performance landing.

### Short Stops

Even with all that, unacceptably short stopping distances can be achieved from almost the first landing. Stopping distances of about 150 ft were achieved on the second landing and distances as short as 120 ft were attained after some practice.

Approach-to-land landings were made and some of them had more than 500 ft to achieve a complete stop. More, who has done the test piloting work on the Wren, was able to land consistently in about 160 ft from touch-down to stop.

Radios stated various positive things about the low-speed regime, partly because of the lift at extension added to the top and partly because the aerobically vortex generation reduces the yawing tendency of the aircraft as a



STANDARD CRUSADE cockpit arrangement has been altered only by the addition of an instrument panel flap control which gives accurate low-speed true airspeed readings. There are no additional flight controls for the ULS system.

bank, so that less rudder is needed to compensate for it during landing.

Robertson has been able to achieve the Wren's slow-speed capability by making only five major changes in the basic Crusade, none of which involve the load-carrying structure, gross weight or engine.

Vertical fin and rudder, as noted above, have been lengthened 11 in. Stronger radials will be standard on production models, rather than the weak Crusade design, because of their slightly better performance at low speeds.

Small ventral fin, made of ion thick aluminum, was added to increase the fin surface and to provide a tail stud on case the aircraft was flared or raised too sharply.

On the prototype, pitch was added to the landing flap of the cabin door to give the aircraft—1958 Schlatter—the same shi-shed landing that the production aircraft will have. Wren plans to use new Crusade 180/181 as

the basis for production aircraft.

Also on the prototype, new trim tabs were added to the elevator to duplicate the arrangement found on the 132.

Full span, double-slotted, Fowler-type flaps were added to the wing, with the rear outboard section acting as the ailerons in both the extended and retracted positions.

Doublets of 0.6 in thick aluminum were added to the rear wing spar at each of the four hinge points and 1/2-in-thick flap hinge support plates were bolted to the doubler.

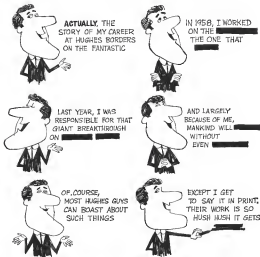
### Flap Hinges

An open sealed bearing is located at the bottom of the hinge and the flap wing entirely on the hinges, without tracks or rails. Three gap points are provided. Double-roller linkage moves the hinge so that the three pivot points are in line when the flaps are fully extended.

Control on the standard Crusade cabin lever and gearshift arrangement.



## THE CLASSIFIED ENGINEER



You work on more of the **WOW** jobs at Hughes! Plus a great many projects and programs we can mention. Like **TPX(N)**—Electronics, **MARIN**—Mobile Mid-Range Ballistic Missile (Integration, Assembly & Checkout), **Sunspot**—Lunar Landing Vehicle System—Synchroscan orbit Communications Satellite, **VARS**—Automated Test Equipment for ballistic missiles, **BAMBI**, **Archiballistic** missile systems—and many others. Hughes are open to all levels for specialists with degrees from accredited universities and U.S. citizenship.

**CONTROLS ENGINEERS.** Controls systems computers and other controls subsystems for missiles and space vehicles utilizing microprocessing control circuits, control systems, control techniques, computer and simulation hardware and control development.

**DESIGN ENGINEERS.** Defense systems requirements for missile systems vehicles, systems and supporting ground equipment to carry out various technical direction to assure mission integrity. Research and design, system design, system design and control effects, new concepts, defense portions of the system.

**SYSTEM DESIGNERS.** Vehicle analysis and systems of systems for defense and aerospace electronics systems (space, high efficiency power supplies for defense and space electronics systems, radar control, space navigation, air defense and control systems, and many others).

**MISSILE ENGINEERS.** Defense systems design requirements for advanced air launched missiles. The design of configurations to meet customer requirements and theoretical analysis of system performance, requirements and characteristics, design and development of new products to build the system requirements.

For immediate consideration please submit your resume to:  
**Mr. Robert A. Martin**  
Recruitment Department  
Hughes Aircraft Company  
3900 W. Jefferson Blvd.  
Culver City 70, California.

Equal opportunity employer.

**HUGHES**  
AEROSPACE DIVISION

AEROSPACE DIVISION

An equal opportunity employer.

with two outboard spoils added to the flap control cable.

Alarms on the prototype is counterbalanced by a weight on an arm extended forward under the wing. In the production version, this will be done with a mass counterbalance in the silicon leading edge. Counterbalance will be 1100's. Conventional silicon control is used.

### Vertex Generators

Minivert-vertex generators (called Wren's Teeth by the company) are located in the silicon by a direct push pull control and which works over a dual-coiler linkage so that the vertex generators move only with spinless.

They are flat pieces of aluminum clamped outward 18 deg. from the wing's upper surface (see front view, p. 117). Normally, the vertex generators lie on the airfoil across the wing. When spinless is applied, they pivot so that the forward edge moves outward toward the wing tip and the trailing edge moves inward.

This act sets causes turbulent air flow over the rear opposing surface and increases silicon effectiveness, but also creates drag to counterbalance the drag generated by the low silicon on the opposite wing. Yawing tendency created by this silicon drag is thereby reduced.

Robertson estimates that the silicon would begin to lose their effectiveness at about 45 mph, without the control generators. With them, he says, the silicon remains effective through the supersonic Mach 3 speed.

### Leading Edge

There are no structural changes forward of the main wing span, but the leading edge of the wing has been increased to about twice its normal value by adding a 0.16 aluminum plate at about the 1/8 chord line on the top of the wing and making the leading edge of the wing droop slightly.

This method of reducing the air on's stalling speed was chosen over the more complicated air arrangement because it is simpler and constantly operating. There is no special at which it occurs to be effective.

It is not as efficient as what would be, but Robertson says it is good enough for Wren's work since that it does not have a tendency to give asymmetrical lift, as it does occasionally do.

The increased droop gives linear flow characteristics back to about the 1/8 chord line. Robertson used a second wing, still set at about a 15 deg angle of attack. One with a flat arrangement will stall at about a 35 deg angle of attack. The Wren wing falls in between these two extremes, suffering less drag than a 15 deg angle of attack, he said.

Ultra-low speed controls, mounted immediately behind the propeller to make use of the slipstream in providing pitch control at low speed, are of single-axis construction with 151 wing-mounted aluminum skin.

Single spar of 4130 chrome alloy attaches to triangle side frames located beneath the engine cowling. Side frames are joined by a center ribbed plate.

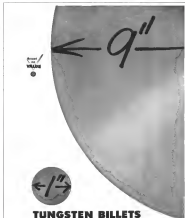
Enter system, including the push pull rod extended through the firewall, weighs about 13 lb.

Two two-way frames attach directly to the engine mount with four bolts, and a lift bolt is located at the out-

board end of the spar, to hold the control surface on. Withstands is attached to the engine mount with two bolts and trims the lateral loads. Side frames take the vertical loading.

Control surface is articulated by means of a linkage which holds the second movable section of the control surface at a given distance from the linkage's pivot point. This cap is built into the prototype, but will be plastic on the production aircraft, Robertson said.

The curved ULS surfaces are covered of the aircraft's center of gravity and work in opposition to, but in conjunction with, the elevator. Robertson



## TUNGSTEN BILLETS

1" to 9" IN DIAMETER and pressures up to 100,000 psi General Electric PS (pressed and annealed) Tungsten can be made in almost any size and shape you need, in blocks and preforms for forging, in slabs for rolling, in flat round bars for vacuum arc melting. In shapes and forms for direct machining and massive hardware, crucibles, furnace boats, etc.

Where you just use the standard properties of tungsten? HIGH melting point, excellent high-temperature strength, good thermal conductivity, good erosion

resistance. General Electric PS Tungsten may be just material!

General Electric PS Tungsten also gives you the advantages of high purity (99.95% minimum) and high density (19.3 minimum). General Electric can supply you with PS Polytungsten, also with General Electric Co., Lamp Metals and Components Department A9-26, 31600 Tungsten Rd., Cleveland 17, Ohio.

Hughes is Our Most Important Product

**GENERAL ELECTRIC**



# DON'T LEVEL OFF ... GROW WITH Honeywell

Every day we are called upon to solve the broad and specific problems related to precision navigation systems and techniques. Every day we look for qualified engineers and scientists to share our education, contribute to our accomplishments and enjoy the personal and professional rewards of achievement. Such projects as Gemini, Dyna Soar and Centaur indicate the important space projects with which we are concerned.

If your capabilities and ambitions are growing steadily, we make your immediate inquiry to the following list of government areas industries, long-range opportunities exist at all levels.

Systems Engineers/Class. Designers/Logic Designers/Anal. Systems/Programmers/Packaging Engineers/Robotry Component Designers/Systems Test Engineers/Materials & Component Engineers/Nav. Equipment Designers/Manufacturing Prototype Development Engineers/Reliability Engineers/Quality Control Systems Engineers

And remember, you and your family will enjoy Florida's beautiful living. The largest move about how YOUR career can grow at Honeywell, write, to headquarters, to Mr. M. H. Koss, Honeywell, 3380 U. S. Highway 29 St. Petersburg, Florida. We'll reply promptly.



## Honeywell

AN EQUAL OPPORTUNITY EMPLOYER  
A Good Place to Live - A Good Place to Work™

To investigate professional openings in other Honeywell facilities send your resume to:  
M. F. Koss, Honeywell, Minneapolis, & Minnesota

HONEYWELL ENGINEERS ARE DOING THINGS IN FLORIDA

estimate they parallel about a 600-lb. payload and across the total lift of the aircraft about 12%. Download on the horizontal lift required to balance the aircraft is reduced from approximately 100 lb. to about 160 lb.

When plans to purchase new 180/182 aircraft from Cessna defines, paying standard market prices, since Cessna has a continuing agreement with its development program and will not divert from the factory to anyone except a governmental organization.

Aircraft will be flown to Waco's production facility—currently located at Mountain Field—and modified. Since space here is limited, Waco has been considering larger production facilities. Current manufacturing space would produce production of only about 1045 aircraft per month.

Rates development program has been partly financed by Robertson, Moore and E. H. Poling, vice president-engineering, who formed the company early last summer. Robertson has applied for patent rights on the control system.

Moore has done extensively in South America, where he engaged in back country aircraft charter work, and much of the design of the 450 reflects his experience.

Interest has been shown in the Waco by Cessna, and that company now has a report in hand recommending the modification of one or two Cessna 285 aircraft.

The Air Force and Army may be interested in the modified aircraft.

It is possible that if the Army's fleet of G-12 (L-19) Bad Dog aircraft were fitted with the Waco control system, their useful life would be considerably increased.

Federal Aviation Agency certification is expected this summer by the company. Sales, at first, will be handled directly from the factory, with exports outside the domestic and South American markets. Twelve-page plan call for a South American sales tour during August and September.

## PRIVATE LINES

Mooney Aircraft dollar volume for the first quarter of Calendar 1965 is up 95% over the same period of 1962. Increase is attributed largely to addition of the Mooney Master fixed-wing version of the Mink 21 to its line. Between Jan. 1 and Mar. 15, Mooney delivered 60 Masters and 90 Mink 21s.

Private helicopter will be constructed by Franklin Engine Co., Syracuse, N.Y., adjacent to its factory, to facilitate test installation of Franklin engines in various model helicopters. At present, en-

gines are being shipped to modification centers for installation. Once helicopter can land at the Tuskegee factory, the company will undertake engine overhaul work on older helicopters.

"Starting and Managing an Aviation Fixed-Bid Operation" is a new booklet available through the Small Business Administration, Washington. SBA points out that profitable operations are likely for agencies from up to \$170,000.

General aviation manufacturers and clients reported to the Federal Aviation Agency that 47% in 1962, the FAA has reported in 1963 1,660 malfunctions or defects were reported, compared with 3,897 in 1961. But, in the number of defects reported was largely due to the added emphasis by FAA on such reports being made, rather than the increase of added malfunctions, the FAA said. As a result, 39 manufacturers, Aerochemics Division, were issued along with 106 manufacturers service instructions or recommendations reports.

Full-scale testing of the 100-lb. modified DH-121 jet aircraft, evaluation, transport has been undertaken by Lockheed World Airlines in Toronto, Ontario, Ltd., in Montreal, since it will be assembled and delivered for export in the next National Research Aircraft Year convention in Houston Sept. 24-27. Toronto is Canadian distributor for the DH-121.

Improving T500A and T500B gas turbine engines, improved versions of the T501.9 and 9A respectively, have received Federal Aviation Agency certification. Both are scheduled for use in the Bell 204B helicopter.



## Attitude Indicator

Trecom helicopter attitude indicator with dual bank needle and ball is being marketed by Len Singer, Inc. Model 4077 is standard 5-in. panel opening and will operate from either 5 or 20V power supply. Price now is provided up to 10 day case up to 25 day case down.

## Aeronautical Engineers:

If you want to do research work on advanced aircraft concepts

## Join the TRECOM team

Yes, we stress AIRCRAFT because we're the Army's Transportation Research Command (TRC)—and we have from only those engineers who are truly interested in measuring the limits of advanced aircraft vehicles. The scientific, labor, power or exact vehicles for air and high performance helicopters, VTOL, and STOL aircraft, and more individually-controlled aircraft vehicles.

"We're the cost of advanced aircraft that will be considered ready for those concepts, research, design, and special equipment—many of which will have a high impact on the commercial marketplace as well. Here are some of the projects at the works at TRECOM today:

- A flexible wing vehicle capable of being jacked into a parachute and again will be used by subsonic combat troops, steady, directed attack.
- The XV-4A VTOL aircraft, with the jet engine capable of carrying two men at high subsonic speeds.
- A new Hot Gas Turbine Jet Motor System represents a revolutionary technique for increasing helicopter speed and payload.
- Small rocket lift devices (Rocket Dots) have been tested by propelling a man through a series of low-level altitudes.



ARMY XV-4A JET EJECTOR VTOL RESEARCH AIRCRAFT

- Airacrafts
- Propellers
- Structures & Materials
- Dynamics
- Stability & Control
- Aircraft Safety Systems
- Instrumentation
- Cardiac System Design
- Flight Performance

If you're interested in both and applied research, please submit a resume of your experience and education, in a Federal employment center, from locations at any time office in W. L. & E. Egan, Division Personnel Office, Building 200, Box 312 Bldg, plus all the benefits of Career Civil Service.



U.S. ARMY TRANSPORTATION RESEARCH COMMAND

# TRECOM

Fort Eustis, Virginia



# Assignment: Probe, produce, prove... for all aerospace projects USAF

The urgently important mission of developing, equipping and supporting all aerospace systems for the Air Force calls for talents of the highest order. The Joint Professional Placement Office has been given the responsibility of coordinating specific needs for the superbly trained and qualified specialists who share the burden of this vital mission. Those outstanding people find, through JOAPO, their place in the call to military service of the Air Force Systems Command and the Air Force Logistics Command.

The specialists: the engineers, the people of dozens of different disciplines who take part in these pro-

grams, feel the sense of agency that calls forth the fullest utilization of their talents. At 28 different installations across the country, JOAPO places these people in challenging positions that have the additional advantages of full Civil Service benefits.

Personal policies provide for maximum possible freedom of expression and exchange of data — how, where, when and with whom — for individual accomplishments plus opportunity for advanced study. The AFSC and AFLO are now staffing the positions below. A BS, MS or Ph.D. degree is required for each, as well as appropriate experience in the areas listed.

## FLUID FLIGHT MECHANICS

Will be responsible for modeling, testing and working in the solution of performance problems of advanced aircraft, plus weapon systems.

## INSTRUMENTATION AND CONTROL

Position requires versatile background in Electronics Engineering applied to advanced, remote guidance systems. Must have mobility and background to deal directly with contractors.

## RANGE INSTRUMENTATION

Will work on all aspects of sophisticated missile stage instrumentation. Must have extensive background in telemetry and calibration.

## PROPULSION AND POWER

Responsibilities will include resolving complex problems of advanced and/or unconventional nature related to liquid and solid propelled rocket engines.

## MATERIALS

Activities will encompass the mechanical design and direction of the fabrication of experimental systems or devices that are new or novel. Will have responsibility for proper choice of materials.

## ELECTRO-MAGNETICS

Will have extensive experience in the Electro-Magnetic technology. Must have skills to apply new advances in the area of advanced electronic systems.

## SOLID STATE DEVICES

Must have thorough understanding of solid state design techniques and a proven ability in applying this knowledge to the design and development of advanced components and subassemblies.

## SYSTEMS MANAGEMENT

Will be responsible for major aspects in the management of advanced systems development. Must show demonstrated managerial ability.

Other select openings are available in Flight Systems Data Processing, Measurement and Wire Communications.

Need resumes and/or Civil Service Application (SF5) in full professional confidence to:

**AFSC/AFLO Joint Professional Placement Office**  
307 Madison Avenue, Dept. 3, New York 23, N.Y.

An Equal Opportunity Employer

AFSC/AFLO

JOINT PROFESSIONAL  
PLACEMENT OFFICE

## WHO'S WHERE

(Continued from page 25)

### In the Front Office

Raymond D. Kelly has been named to represent the Air Transport Section on the Federal Aviation Agency's new corporate management System Analysis Team. Mr. Kelly, an Air Force USAF Lt. Col., was in a position of technical development.

Col. Gerald J. Day, commander, Federal Air Command's 1st Air Command Group, Hartford Field, Pa.

Dr. Frederick A. Mueller has been appointed by the National Aeronautics and Space Administration to its Research and Development Committee on Control, Guidance and Navigation. Dr. Mueller is a senior scientist on the Science Systems Department of Martin Co. Electronics Systems and Production Div.

### Honors and Elections

Vernon R. Ransing, vice president of Martin Co.'s Baltimore facility, has received the 1967 Air Force Achievement Award for his "outstanding contributions to the defense strength and security of the United States and the Free World by winning timely solution of its Inter 1 and Titan 2 engine problems."

Gen. Thomas Oliver White (USAF, ret.) has been named the 1967 recipient of the General William L. Mitchell Award Award which is presented annually to the United States citizen making the outstanding individual contribution to aviation progress.

### Changes

Dr. Arthur H. Komer, director of engineering military systems, Lockheed Electronics Co., Mansfield, N.J.

C. R. Kass, appointed White, has been appointed to the International Civil Aviation Organization with office in Cairo, Egypt.

James G. Humes, director of advanced programs for Martin Co.'s Orlando (FL) Div., and John F. Butterfield, associate director of technical operations, New York E. Walker, director of research, Dr. Allen H. Ryan, head of a newly created development unit, Dr. C. D. Brown, Jr., technical director reliability and maintainability.

Frank W. Wolcott, head of the newly established Systems Engineering Division, Research Analysis Corp., Bethesda, Md. Also: Dennis M. Golik and Ronald S. Butler, operations analysts at SAC.

R. Henry Lewis, manager, Range, has been named Laboratory, Western Development Laboratories of Pueblo Corp., Pueblo, Colo.

George Epps, manager, Digital Systems Dept., Omega Electronics Corp., Van Nuys, Calif.

Bobby Gillespie, chief of Planning Materials Planning Office, of Mission Spec. High Altitude Aeronautics and Space Mission Institute, Washington, D.C.

Robert Lee, administrative director, TRL managing Corp.'s Electronics Systems and Data Instrument Division, North Hollywood, Calif.

Donald E. Shigley, value analyst, Procurement Dept., Rockwell Corp., Wichita, Kan.



An important position is available for a man with experience in gas dynamics, chemical kinetics and heat transfer as applied to rocket motors. Work, both analytical and experimental, will be in the following areas:

- Thrust vector and thrust magnitude control by secondary injection.
- Exhaust nozzle reconstruction.
- High and low pressure combustion processes.
- Investigation of novel techniques for control of high heat flux.

Projects are of the long-range sustained type and have strong management support. Contributing efforts by experienced specialists with complementary skills are readily available.

Acquaintance and gas dynamics facilities are excellent and will be further improved with the completion of a new rocket test facility. One of the nation's largest analog and digital centers, which is part of the Laboratories, offers mathematical analysis, computational and data reduction services.

Since we are interested in an outstanding individual, salary will be commensurate with experience and ability. A requirement is an M.S. degree or equivalent experience.

Write or call Mr. E. F. Clark COLLECT: Area Code 303, 303 4201, Extension 1146.

## RESEARCH LABORATORIES

422 Main Street, East Hartford 6, Conn.

U  
A

an equal opportunity employer



# AVIONICS ENGINEERS

## ITT Federal Laboratories Awarded Navy Contract for Next-Generation Shipboard TACAN System

In this unusual, multi-laboratory expansion devoted to such diverse pursuits as line of sight, OTH and satellite communication, range and tracking systems, AGM research in the physical sciences, etc., our Avionics Laboratory has contributed an important share of technological firsts over the years. Not the least of these was the original TACAN (Tactical Air Navigation) system developed by ITTL for the military more than a decade ago. Under the terms of a new Navy contract, our engineers are developing advanced TACAN equipment. The three principal units under development are the external transponder beacon and a fully integrated test, monitor and control subsystem which will continuously check out the equipment's operating performance. Latest solid state techniques will be extensively utilized throughout the new system.

Immediate opportunities throughout our Avionics Laboratories call for graduate engineers with demonstrated records of achievement in any of the areas below. Starting salaries range from \$11,000 to \$20,000.

### ASSOCIATE LAB DIRECTOR

Must have a minimum of 10 years' experience in technical direction and managerial aspects of major projects. Extensive background in ITT, GME, AEG Systems and TACAN equipments or systems mandatory.

### SENIOR ENGINEERS

Must have demonstrated ability to lead development and production engineering projects. Specific design experience in one or more of the product lines listed in the description above required.

### PROJECT ENGINEERS

Positions call for design engineering of TACAN equipments plus supervision of a group of engineers and technicians engaged in qualification testing and production release on TACAN equipment.

Notice: New Jersey, site of ITTL's major laboratory complex, is just 35 minutes drive from the heart of New York City. Yet you can choose from scores of nearby suburban communities offering excellent value in housing, modern schools, shopping centers. Northern New Jersey's famous lakes, the world-famous Jersey coastline, golf... in short, a fine cultural and recreational setting for the entire family.

For a prompt review of your qualifications, and a confidential reply, forward your resume today to Mr. W. F. Bernard, Box 1169,

**ITT FEDERAL LABORATORIES**  
800 Washington Avenue, Mully 92, New Jersey  
An Equal Opportunity Employer

## FOR INFORMATION

about Classified Advertising

contact the McGraw-Hill  
office nearest you

ATLANTA, 9 J. Hall  
1375 Peachtree St., N.E.  
Thursday 3-0923

BOSTON, 16 G. Dove  
Capley Square CDegree 3-1160

CHICAGO, 11 W. J. Higgins  
642 N. Michigan Avenue  
MDirect 4-5830

CLEVELAND, 13 B. Hughes  
1164 Blumhardt Bldg.  
Monday 3-7300

DALLAS, 3 J. Grant  
1712 Commerce St., W. Hughes Bldg.  
Thursday 3-8721

DENVER, 2 J. Fortes  
1700 Eisenhower Tower Bldg.  
Alpine 3-2961

DETROIT, 34  
516 Penobscot Bldg.  
WDownland 3-1793

HOUSTON, 35 J. Page  
Princeton Bldg., Room W-724  
Midtown Bld. E-1250

LOS ANGELES, 17 B. McGinnis  
1133 W. 4th Street  
Monday 3-8450

NEW YORK, 34  
W. T. Buchanan/D. Harkley  
500 Fifth Avenue  
LDegree 4-3066

PHILADELPHIA, 3  
W. B. Sullivan/D. Lewis  
Box Penn Center Plaza  
LOure 4-4338

PITTSBURGH, 32  
4 Calvary Center  
EXpress 1-1214

ST. LOUIS, 9 J. Greco  
7731 Cassinville Avenue  
PLuewren 5-7283

SAN FRANCISCO, 11 J. A. Harkley  
258 California Street  
GOogle 3-4608



ENGINEERS • SCIENTISTS • JOIN US IN GIVING A NEW DIRECTION TO AEROSPACE TECHNOLOGY

## SPACE STATION — Only one of the critical aerospace areas in which Republic's Paul Moore Research Center is conducting company-funded programs

To create a new stepping stone into space, Republic scientists and engineers are developing specifications for a manned space station. Launching into a 200-mile orbit by a single booster, this space laboratory will automatically orbit to provide about 2000 man-hours for a 90-day mission. Here, man and equipment will undergo a myriad of scientific experiments.

Studies of zero-gravity effects, respiratory environments, feeding and waste disposal and a host of other problem areas will provide a fund of knowledge for future stations and further exploration of the solar system. On this and other space programs — such as Lunar Logistic Systems, Project Fire, and OMS — engineers and scientists are invited to consider openings on Republic's space team. Opportunities at all experience and degree levels exist in the following areas:

### SPACE SYSTEMS CONCEPTS

/ advanced systems analysis / orbital systems / navigation and guidance systems / telemetry systems / communications systems / computer systems / radio systems / respiratory systems / data processing systems / special space station studies

### SPACE VEHICLE STRUCTURES, PROPULSION, MANEUVERING

/ aerodynamic testing / thermal energy transfer / environmental control / landing gear study / load and stress analysis / structural analysis / thermal protection systems / vibration systems / weight control / microelectronics

### EXPERIMENTAL AND THEORETICAL ELECTRONICS RESEARCH

/ communications / circuits / radio and radio wave control / antennas / transmitters / signal and microwave devices / control systems / signal processing / solid state components / experimental instrumentation

### MATERIALS RESEARCH

/ high-temperature material technology / solid state and special materials / electronic materials / high-temperature material properties / materials characterization / space technology / photochemical processes / plasma

### PHYSICS — THEORETICAL & EXPERIMENTAL

/ solar wind physics / cosmic rays / microphysics / plasma physics / particle and nuclear physics / hydrodynamics / chemistry / astrophysics / atmospheric physics

### LIFE SCIENCES, SPACE ENVIRONMENTS

/ human factors / life support systems / radio biology / biotechnology / toxicology / nutrition

### APPLIED MATHEMATICS

/ statistical methods / statistical analysis / statistical control theory / signal processing / statistical analysis / Monte Carlo

### HYDRODYNAMICS

/ hydrodynamic analysis / design / problems / design & model / mass transport / aerodynamics / hydrodynamic testing / simulation / dynamic systems / analysis & design research / plasma / air flow & supersonic / aerodynamic research / space technology / hydrodynamic testing

### Write us at Eastchester 100

Mr. George H. McKenna,  
Professional Employment  
Manager, Dept. D-3

An Equal Opportunity Employer

**REPUBLIC**  
AVIATION CORPORATION  
AEROSPACE TECHNOLOGY













ADDRESS NOT REPLIED to see the  
 1968-1969 A-100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.

**POSITION VACANCY**  
 Helicopter Engineer, B & P Helicopters, Inc.,  
 10000 S. Main St., Suite 100, Los Angeles, CA 90047  
 Phone (213) 551-1111

**POSITIONS WANTED**  
 Engineer, B & P Helicopters, Inc.,  
 10000 S. Main St., Suite 100, Los Angeles, CA 90047  
 Phone (213) 551-1111

**Aviation Electronics Repair—Los Angeles**  
 Electronic Repair Shop, 10000 S. Main St., Suite 100,  
 Los Angeles, CA 90047. Phone (213) 551-1111

**AVIATION WEEK**  
 10000 S. Main St., Suite 100, Los Angeles, CA 90047  
 Phone (213) 551-1111

**Wanted—Mechanics, Engineers, Technicians, etc.**  
 10000 S. Main St., Suite 100, Los Angeles, CA 90047  
 Phone (213) 551-1111

**MECHANICAL ENGINEERING WANTED**  
 10000 S. Main St., Suite 100, Los Angeles, CA 90047  
 Phone (213) 551-1111

**NEED EXPERIENCED ENGINEERS?**  
 10000 S. Main St., Suite 100, Los Angeles, CA 90047  
 Phone (213) 551-1111

**Place an "Engineers Wanted" advertisement in the EMPLOYMENT OPPORTUNITIES section. It's an inexpensive, time saving method of selecting experienced personnel for every engineering job in the electronic industry. The selective circulation of AVIATION WEEK offers you an opportunity to choose the best qualified man available throughout the industry.**

**AVIATION WEEK**  
 Classified Advertising  
 Fee Office Box 12, New York 23, New York

# SEARCHLIGHT SECTION

**FOR SALE**  
**HELICOPTERS**  
 3 SIKORSKY S55-B PLACE  
 AIRLINE PASSENGER CABIN  
 RAPID CONVERSION FOR CABO  
 LATEST DESIGN CHANGES  
**FOR DEMO INFO**  
**L. A. AIRWAYS, Inc.**  
 LEO AIRFIELD, WOODLAND AIRPORT, L. A. 9

**TIMMINS**  
**AVIATION LIMITED**  
 MEMBERS: INTERNATIONAL, AIRCRAFT  
 10000 S. Main St., Suite 100, Los Angeles, CA 90047  
 Phone (213) 551-1111

**Immediately available**  
**FOR SALE**  
**P-W 82000-792/85/SD-136**  
**ENGINE**  
**FOR SALE**  
**FOR SALE**  
**FOR SALE**

**Wanted—Mechanics, Engineers, Technicians, etc.**  
 10000 S. Main St., Suite 100, Los Angeles, CA 90047  
 Phone (213) 551-1111

**Wanted—Mechanics, Engineers, Technicians, etc.**  
 10000 S. Main St., Suite 100, Los Angeles, CA 90047  
 Phone (213) 551-1111

**TIMMINS**  
**AVIATION LIMITED**  
 MEMBERS: INTERNATIONAL, AIRCRAFT  
 10000 S. Main St., Suite 100, Los Angeles, CA 90047  
 Phone (213) 551-1111

**For Immediate Sale**  
**3-006A/B AIRCRAFT**  
 10000 S. Main St., Suite 100, Los Angeles, CA 90047  
 Phone (213) 551-1111

**CONVAY 340/440**  
 10000 S. Main St., Suite 100, Los Angeles, CA 90047  
 Phone (213) 551-1111

**BROOKHAVEN AIRPORT**  
**AIRCRAFT REPAIR SECTION**  
 10000 S. Main St., Suite 100, Los Angeles, CA 90047  
 Phone (213) 551-1111

**TIMMINS**  
**AVIATION LIMITED**  
 MEMBERS: INTERNATIONAL, AIRCRAFT  
 10000 S. Main St., Suite 100, Los Angeles, CA 90047  
 Phone (213) 551-1111

**For Immediate Sale**  
**3-006A/B AIRCRAFT**  
 10000 S. Main St., Suite 100, Los Angeles, CA 90047  
 Phone (213) 551-1111

# ADVERTISERS IN THIS ISSUE

AVIATION WEEK, April 15, 1968

ADVERTISERS IN THIS ISSUE	100
ADVERTISERS IN THIS ISSUE	101
ADVERTISERS IN THIS ISSUE	102
ADVERTISERS IN THIS ISSUE	103
ADVERTISERS IN THIS ISSUE	104
ADVERTISERS IN THIS ISSUE	105
ADVERTISERS IN THIS ISSUE	106
ADVERTISERS IN THIS ISSUE	107
ADVERTISERS IN THIS ISSUE	108
ADVERTISERS IN THIS ISSUE	109
ADVERTISERS IN THIS ISSUE	110
ADVERTISERS IN THIS ISSUE	111
ADVERTISERS IN THIS ISSUE	112
ADVERTISERS IN THIS ISSUE	113
ADVERTISERS IN THIS ISSUE	114
ADVERTISERS IN THIS ISSUE	115
ADVERTISERS IN THIS ISSUE	116
ADVERTISERS IN THIS ISSUE	117
ADVERTISERS IN THIS ISSUE	118
ADVERTISERS IN THIS ISSUE	119
ADVERTISERS IN THIS ISSUE	120
ADVERTISERS IN THIS ISSUE	121
ADVERTISERS IN THIS ISSUE	122
ADVERTISERS IN THIS ISSUE	123
ADVERTISERS IN THIS ISSUE	124
ADVERTISERS IN THIS ISSUE	125
ADVERTISERS IN THIS ISSUE	126
ADVERTISERS IN THIS ISSUE	127
ADVERTISERS IN THIS ISSUE	128
ADVERTISERS IN THIS ISSUE	129
ADVERTISERS IN THIS ISSUE	130
ADVERTISERS IN THIS ISSUE	131
ADVERTISERS IN THIS ISSUE	132
ADVERTISERS IN THIS ISSUE	133
ADVERTISERS IN THIS ISSUE	134
ADVERTISERS IN THIS ISSUE	135
ADVERTISERS IN THIS ISSUE	136
ADVERTISERS IN THIS ISSUE	137
ADVERTISERS IN THIS ISSUE	138
ADVERTISERS IN THIS ISSUE	139
ADVERTISERS IN THIS ISSUE	140
ADVERTISERS IN THIS ISSUE	141
ADVERTISERS IN THIS ISSUE	142
ADVERTISERS IN THIS ISSUE	143
ADVERTISERS IN THIS ISSUE	144
ADVERTISERS IN THIS ISSUE	145
ADVERTISERS IN THIS ISSUE	146
ADVERTISERS IN THIS ISSUE	147
ADVERTISERS IN THIS ISSUE	148
ADVERTISERS IN THIS ISSUE	149
ADVERTISERS IN THIS ISSUE	150
ADVERTISERS IN THIS ISSUE	151
ADVERTISERS IN THIS ISSUE	152
ADVERTISERS IN THIS ISSUE	153
ADVERTISERS IN THIS ISSUE	154
ADVERTISERS IN THIS ISSUE	155
ADVERTISERS IN THIS ISSUE	156
ADVERTISERS IN THIS ISSUE	157
ADVERTISERS IN THIS ISSUE	158
ADVERTISERS IN THIS ISSUE	159
ADVERTISERS IN THIS ISSUE	160
ADVERTISERS IN THIS ISSUE	161
ADVERTISERS IN THIS ISSUE	162
ADVERTISERS IN THIS ISSUE	163
ADVERTISERS IN THIS ISSUE	164
ADVERTISERS IN THIS ISSUE	165
ADVERTISERS IN THIS ISSUE	166
ADVERTISERS IN THIS ISSUE	167
ADVERTISERS IN THIS ISSUE	168
ADVERTISERS IN THIS ISSUE	169
ADVERTISERS IN THIS ISSUE	170
ADVERTISERS IN THIS ISSUE	171
ADVERTISERS IN THIS ISSUE	172
ADVERTISERS IN THIS ISSUE	173
ADVERTISERS IN THIS ISSUE	174
ADVERTISERS IN THIS ISSUE	175
ADVERTISERS IN THIS ISSUE	176
ADVERTISERS IN THIS ISSUE	177
ADVERTISERS IN THIS ISSUE	178
ADVERTISERS IN THIS ISSUE	179
ADVERTISERS IN THIS ISSUE	180
ADVERTISERS IN THIS ISSUE	181
ADVERTISERS IN THIS ISSUE	182
ADVERTISERS IN THIS ISSUE	183
ADVERTISERS IN THIS ISSUE	184
ADVERTISERS IN THIS ISSUE	185
ADVERTISERS IN THIS ISSUE	186
ADVERTISERS IN THIS ISSUE	187
ADVERTISERS IN THIS ISSUE	188
ADVERTISERS IN THIS ISSUE	189
ADVERTISERS IN THIS ISSUE	190
ADVERTISERS IN THIS ISSUE	191
ADVERTISERS IN THIS ISSUE	192
ADVERTISERS IN THIS ISSUE	193
ADVERTISERS IN THIS ISSUE	194
ADVERTISERS IN THIS ISSUE	195
ADVERTISERS IN THIS ISSUE	196
ADVERTISERS IN THIS ISSUE	197
ADVERTISERS IN THIS ISSUE	198
ADVERTISERS IN THIS ISSUE	199
ADVERTISERS IN THIS ISSUE	200

**DEPENDABLE**  
**fuel flow**  
**with ROPER**  
**four gear fuel pumps**

**GENERAL SPECIFICATIONS**  
 10000 S. Main St., Suite 100, Los Angeles, CA 90047  
 Phone (213) 551-1111

**Communications**  
**Equipment Overhaul**  
**and Repair**  
 10000 S. Main St., Suite 100, Los Angeles, CA 90047  
 Phone (213) 551-1111

**LEAR SIEGLER**  
**SERVICE, INC.**  
 10000 S. Main St., Suite 100, Los Angeles, CA 90047  
 Phone (213) 551-1111



## LETTERS

### Leader of the Band

My name is McManus, I'm the leader of the Band. Since survival is our business, We will always take a stand.

To buy performance, or do the job,  
Is the question to be solved.  
The only way to keep the nation going,  
If the bill can't be passed.

Why buy a Ford that does a job  
That's done by many others?  
Or one that's overpriced (or overrated)  
In relation to its features?

Ask what you get for what you pay.  
Performance for its own sake.  
Gas never be the goal.

PETER SCHWARTZ  
Inglewood, Calif.

*Dear Sir:* With welcome the opening of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, *Aviation Week*, 300 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine subscription. We will not print anonymous letters, but some of letters will be published on request.

### Commonality

It is true that Mr. McManus is about to receive a \$10 million contract with the Texas Energy and Development Corp. for a high capacity heavy duty aircraft carrier. I would like to see it in use at least 55 to 60 years, selecting a company with experience in the type vehicle. According to me, Mr. McManus ought to be in command of the Navy that will build in type of aircraft carrier and 10 more aircraft carrier.

John O'Neil  
San Jose, Calif.

### Advancing Schedules

With the successful completion of the North Atlantic research and development flight, and the successful launch of the Gemini spacecraft, a question comes to mind.

The Gemini 1 launch vehicle can get 30,000 lb into a near earth orbit. The Gemini spacecraft weighs 2,800 lb., and a couple of two weeks after its launch orbit. With a Gemini spacecraft mounted atop a Saturn 1, some 15,000 lb., will be available to assist the Gemini to a near earth orbit. This consistent flight could have a number of very beneficial advantages to avoid some aspect, and extensive ground tests could be finished by 1967 as in the successful Mission 2. Furthermore, it could be accomplished by the end of 1964 which is several years ahead of the present schedule using the Saturn 5 vehicle.

Of course, additional tests should materialize would have to be added to the Gemini for superorbital entry. However, only 10,000 out of the available 15,000 lb. would be necessary for the launch mission.

The question is: why don't we attempt such a mission?

Don McManus  
Research Specialist  
Space and Information  
The North American Aviation, Inc.

### Querying MATS

I am a subscriber to your fine magazine and have enjoyed reading the "Letters to the Editor" section especially.

Having been a flight instructor both military and professionally for the past 35 years, I wonder if I may be permitted to ask a few important questions relative to the Military Air Transport Service (MATS)?

- Why does MATS deliver mail to our camp?
- Why are a commercial air carrier's MATS routes at less cost than MATS?
- Why has MATS run out of funds for "call letters" for the last quarter of this fiscal year?
- Does MATS realize that there are more flight crews on foreign, both in the East and West coasts, because of the lack of "call letters"?
- Considering the number of foreign flights that MATS is responsible for, because of military and commercial MATS losses, where are the airlines going to obtain flight crews to fly MATS routes in case of a national emergency? Is MATS so sure to think that civilian flight crews are going to accept routes from foreign so that they may fly into combat areas during a crisis when they did not have the opportunity to fly during normal times in order to earn a living?

If any responsible MATS official would care to answer the above questions, I would be most interested in learning the answers.

John MacGregor  
Flight Navigator  
Wright, L. L., N. Y.



**Another Blue Ribbon Product from cppe**

**NEW, IMPROVED SERVO MOTORS**  
to Help Solve Special Servo Problems

Do you have a particular servo motor problem such as: Power Consumption? Excess Sparking Voltage? High Temperature? Shaking? Single Phase? Low Life?

Let Clifton Precision help you solve it!

The new Clifton Precision feature more power for completely less money! This results in a more efficient and longer running motor.

Acceleration is increased up to 100,000 output at between 2 and 5 watts per phase. This is built on improvement that is carbon motor generates less stress in new Clifton motor in case of failure.

Starting voltage in our new motor is more guaranteed to be 115. New load resistant magnets and improved stator windings make these motors in withstand 300°C plus.

Get Clifton for your special or standard servo motor needs!

**CLIFTON PRECISION PRODUCTS CO., INC.**  
Clifton Heights, Pa.      California Springs, Calif.

**cppe**

**"It's The Ultimate Deterrent Weapon... Only 50 Parts, Each Manufactured In A Different State!"**



**THE WASHINGTON POST**



APR. 16 1963



## Patrolling the seas— a regiment of sentries, armed and fuzed by Avco!

**A fleet of nuclear submarines** cruising somewhere beneath the Seven Seas is keeping a watchful eye on Peace. Each submarine carries sixteen Polaris missiles—powerful sentries—whose arming and fuzing systems were designed and manufactured by Avco.

**Avco's Ordnance Division** works as a team with the Naval Ordnance Laboratory to develop the detonation equipment for these fleet ballistic missiles. Their joint efforts were proved on May 6, 1962, when the United States successfully test-fired a "live" Polaris.

**Avco received the U.S. Navy's** coveted Certificate of Merit for its work on Polaris. Avco is proud to have a part in this important defense program as well as other missile programs to which it is contributing some of its arming and fuzing know-how.

**For more information** about Avco's capabilities in arming and fuzing and related ordnance fields, write: Director of Marketing, Ordnance Division, Avco Corporation, Richmond, Ind.

# Avco

UNUSUAL CAREER OPPORTUNITIES FOR QUALIFIED SCIENTISTS AND ENGINEERS...  
REGARDLESS OF RACE, CREED, COLOR, OR NATIONAL ORIGIN... WRITE AVCO/ORDNANCE TODAY.

